JOURNAL OF THE SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

73d Semiannual Convention • April 27–May 1, 1953 • Los Angeles

NOVEMBER 1952

Society of Motion Picture and Television Engineers
JOURNAL VOL. 59 NOVEMBER 1952 NO. 5

Subscription to nonmembers, $12.50 a year; to members, $6.25 a year, included in their annual membership dues; single copies, $1.50. Order from the Society's General Office. A 10% discount is allowed to accredited agencies on orders for subscriptions and single copies. Published monthly at Easton., Pa., by the Society of Motion Picture and Television Engineers, Inc. Publication Office, 20th & Northampton Sts., Easton, Pa. General and Editorial Office, 40 West 40th St., New York 18, N.Y. Entered as second-class matter January 15, 1930, at the Post Office at Easton, Pa., under the Act of March 3, 1879.

PRINTED BY MACK PRINTING COMPANY, EASTON, PA.

The Economics of High-Speed Photography

By A. C. KELLER

The economics of the use of high-speed photography in research and development work are discussed. High-speed photography is a relatively new tool for engineers which can be used to measure mechanical or electrical effects or both at the same time. Examples are given which illustrate the savings in engineering manpower as well as in materials, devices and systems.

It is a pleasure to accept the invitation of your Chairman to discuss some economic aspects of high-speed photography. Bell Telephone Laboratories, of which I am a member, is, as you know, a research and development organization and, for this reason, I will cover the uses and the value of high-speed photography in this area and will take my illustrations from the communications field.

In addressing your Society, of which I have been a member for many years, I would first like to have you observe that it is a society of engineers. I would next like you to remember what the characteristics of an engineer are, particularly in contrast to those of the scientist, physicist, mathematician, etc. As you know, the engineer is indeed interested, and must be trained and informed in, scientific matters *but* he has an additional responsibility which is in his thoughts and actions at all times. This added characteristic of the engineer is his constant concern with the economic value of his activities. He always wants to know, and must know, whether his projects are sound economically.

In order for the engineer to determine the economic value of his work, he must have suitable "tools." The tools which an engineer uses are of many different kinds but none are more important than those which are used for measurement purposes. He must be able to measure many different things in many different ways in order to determine the relative economics of competing solutions of his problems.

Almost sixty years ago, Lord Kelvin discussed the importance of measurements as follows: "When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot

Presented on October 8, 1952, as the keynote speech for the International Symposium on High-Speed Photography, at the Society's Convention at Washington, D.C., by A. C. Keller, Bell Telephone Laboratories, Inc., 463 West St., New York 14, N.Y.

measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be." This observation is probably more important today than it was sixty years ago, because our apparatus and systems have become more and more complex and operate faster and faster.

One of the most important of our relatively new measuring tools is high-speed photography. The use of high-speed photography in research and development work leading to new devices and new systems and in understanding older devices, is becoming increasingly important. In our own organization we have established a regular service for the use of engineers, which is readily available, in the form of a variety of good equipment and skilled people to operate the equipment.

As measurements are taken of apparatus or systems we frequently change our ideas of how and why devices act as they do. I can think of no other tool available to the engineer which has caused him to change his view of things as much as high-speed photography. Intuition is a valuable human trait but it may easily lead us astray in engineering matters. It has been said that our troubles are not always due to facts we do not know but frequently to those things that we are sure are true but which are in reality untrue. This applies particularly to those things which operate so fast that they cannot be seen or judged by the naked eye. High-speed photography extends our limited human powers of observation. It not only expands time so that we can readily see what happens in extremely short periods of time but it also makes possible the quantitative measurement of these effects.

High-speed photography itself is a broad field of activity and has been covered in many excellent papers which have appeared in the *Journal* of this Society. However, for the application to research and development work, it is important to know that high-speed photography is capable of expanding time for mechanical or electrical effects, or for both at the same time. It can be used to study fast complex mechanical motions and it can also be used to study cathode-ray oscilloscope traces of high speed. The ability to do these things quantitatively has an important economic value.

The economic value of the use of high-speed photography comes about in two major ways:

1. As a saving in manhours of engineering effort by doing a job with fewer men, or—more likely—by doing more jobs with the same men; and
2. As savings in materials, devices or systems either by avoiding failures in service, by extending the useful life of these items or by making faster operation possible so that less equipment may be used to perform the required operations.

To illustrate these savings, some specific examples can be cited taken from the experiences at Bell Telephone Laboratories in research and development activities.

A good illustration of the savings in engineering manpower is the case of the development engineer working on a new and complex mechanism. Without high-speed photography, it might be necessary to build a series of mechanisms and to test all of them for performance and life, a very expensive proposition both in material and in engineering manhours. From the experience gained with such a large variety of designs, it would then be possible to select one particular design for application. In contrast, the more modern practice of using high-speed photography enables the engineer, sometimes from a single model or parts of a model, to determine by measurement whether

there are serious shortcomings in the newly designed mechanism and what the nature of the difficulties is. In this way modifications can be made to solve problems that may not even be known to exist without the help of high-speed photography. These methods have been used with outstanding success in many of our research and development projects, particularly those associated with the complex electromechanical mechanisms which are used in telephone central office apparatus.

A good example of the savings in materials, devices or systems which result from the use of high-speed photography is one that is present in many mechanisms, namely, that of cam actuation where continuous contact between the cam and its follower must be had for quiet operation, longest life and highest operating speed. Another good example is the telephone relay used in switching systems. Each of these relays has an armature operated by an electromagnet. A common problem with relays is that of armature rebound when a relay is released. The armature may bounce one or more times and set up other undesirable vibrations in the structure. In order to avoid false contact operation, it is necessary to wait until the effects are over before again allowing the associated circuits to use the relay. By the use of high-speed photography, it has been possible to redesign relay structures to minimize these vibratory effects and the time for them to be reduced to a neglibible value. Accordingly, the relay can be used by its associated circuit more frequently in a given length of time. In many cases this results in fewer relays in a system to provide necessary operating functions.

From these illustrations it can be said that high-speed photography has made it possible to produce economies in materials, devices or systems by:

1. Extending the life, with corresponding savings in the cost and the materials of replacement units, and
2. Using fewer units to perform the needed functions because higher operating speeds are possible without undue wear.

In order to illustrate the variety of uses of high-speed photography in the research and development area of the communications field, a short motion picture has been prepared. The film has been assembled to indicate the wide variety of uses of high-speed photography in our work. After the showing of the film, I will attempt to summarize the overall economic value of high-speed photography in the work at Bell Telephone Laboratories.

(Examples were shown in a motion picture as follows:

1. stepping switch for dial systems,
2. new wire spring relay for dial systems,
3. crossbar switch for dial systems,
4. mercury contact switch,
5. automatic trouble recorder,
6. cam action in automatic message accounting equipment, and
7. pushbutton telephone set.)

Let us examine the economic value of some of the uses of high-speed photography in the telephone apparatus field. As you know, the Bell System designs, manufactures and uses telephone apparatus and equipment in large quantities to provide much of the nation with telephone service. For example, one of the scenes in the motion picture film showed a study of the step-by-step switch used widely in certain types of central office dial systems. These switches follow the dial pulses and perform other essential operations in establishing a connection between telephone subscribers. Last year the Bell System manufactured more than 600,000 switches of this type. It is obvious that savings of even a small amount on each of this large number of switches would result in a substantial sum of money. In the same way, general purpose relays are used widely in telephone switching systems, and in some of the modern crossbar systems about

five of these are used for each telephone subscriber, so that the total number produced each year is of the order of five million units. Here again, small savings, either in the cost of the relay, its maintenance or in a reduction of the operating time of the relay, have a high economic value because a large number of them are produced and used each year.

Another view of the value of high-speed photography in Bell System research and development work can be taken from the fact that about 700 to 800 100-ft reels of high-speed motion picture film are taken each year. Most of these are carefully studied, frequently by a group of engineers. From these studies, conclusions are reached which result in new and better understandings of the devices and frequently design changes or new designs are the result. Faster processing service of the film would be helpful in expediting development work.

The exact dollar value of the engineering manhours and materials which have been saved by the use of high-speed photography is difficult to evaluate but it is obviously very large in important research and development activities. On one particular project of a device made in large quantities for telephone use, the project engineer estimated that savings of several hundred thousand dollars a year had resulted. Other projects have saved much less and some have shown even larger savings.

In closing, I would like to say that there are many other economic advantages in the use of high-speed photography in maintenance problems, training problems, etc., which I have not touched upon in outlining the engineering value of this tool in research and development work. Our daily use of high-speed photography, leads us to expect an expanding application of this new and important engineering tool and as a result will make better use of that most precious commodity — engineering manpower.

Transient Pressure Recording with a High-Speed Interferometer Camera

By WILLARD E. BUCK

This paper describes a transient-pressure recording camera with a full scale pressure range (by changing diaphragms) of 3 psi to 50,000 psi, and an accuracy of one-half per cent of full scale for any range. Its stability and hysteresis are such that a single static calibration suffices for years of dynamic measurements, and its frequency response varies from 10,000 cycle/sec to 100,000 cycle/sec, depending on the pressure range of the diaphragm used. The paper includes records of interesting applications.

Conventional pressure gauges which have high frequency responses are built as follows: A pressure-sensitive device with the required natural frequency (usually a diaphragm or a form of Bourdon tube which has a minute displacement or rotation proportional to pressure applied) is the heart of the instrument. This small rotation or displacement is converted into an electrical response by an electromechanical transducer of the designer's choice, usually either a variable condenser or variable reluctance device. The small electrical impulse thus obtained is amplified and recorded without losing the characteristics of the original signal.

For frequency responses above about 2000 cycle/sec, the most convenient presentation is on a cathode-ray screen. However, if these fleeting signals are to be studied, they must be recorded on photographic film; and further, if the event lasts longer than a very small fraction of a second a continuous moving film camera is usually required.

It is obvious that recording the movement of a diaphragm directly on the photographic film is highly desirable if the system is sufficiently sensitive and has the required frequency response. Such a system exists in the familiar form of interference fringes which can be recorded directly with a moving film camera.

The unique properties which make this system an ideal amplifier are worth further discussion. The amplification factor, defined as the ratio of distance moved by the center of the diaphragm to the corresponding change in fringe diameter, is 14,620 for a fringe pattern using the 5461 A line of mercury and having a distance between light maxima of 2 mm. The frequency response of such an amplifier is approximately half the frequency of the light used. In this example it would be approximately

Presented on October 10, 1952, at the Society's Convention at Washington, D. C., by Willard E. Buck, University of California Los Alamos Scientific Laboratory, P. O. Box 1663, Los Alamos, N.M.

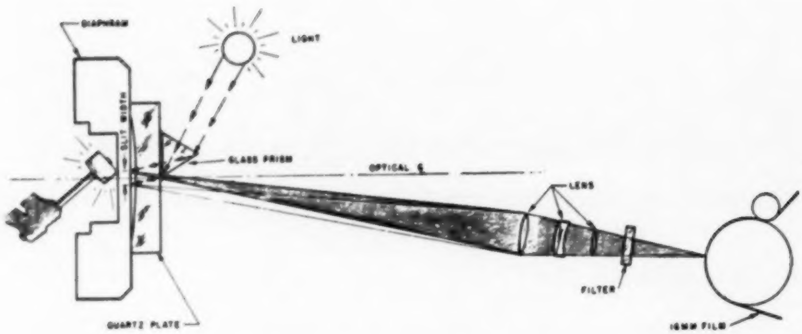


Fig. 1. Schematic of optical system used on interferometer gauge.

2.7×10^{14} cycle/sec. The gain of this amplifier is as constant as the wavelength of light. This, of course, is as good as any quantity we know of and is actually used as the fundamental standard of length measurement.

With such a satisfactory amplifier the characteristics of a pressure measuring device depend entirely on the mechanics of the diaphragm and the recording system used.

A photographic and optical system designed to use such an amplifier was first described in October 1948,[1,2] but is briefly described here again to clarify the remainder of this paper for those who are not familiar with the interferometer gauge.

Optical System

In Fig. 1, a steel diaphragm is receiving a transient pressure as represented by the hammer blow. The diaphragm deflects slightly in response to the pressure, and it is this slight deflection that we wish to record on the moving film. To do this a quartz backing plate, with one face ground and polished spherically concave on a large radius, is placed next to the flat side of the diaphragm. The outer edges of the plate are ground and polished flat to make a highly stable reference with respect to the steel diaphragm.

The spherical cavity in the quartz is coated with a half-reflecting film of aluminum so that when the assembly is viewed in monochromatic light a set of sharply defined interference fringes, or Newton's rings, is formed. If the monochromatic light is admitted through a glass prism as shown in the diagram, however, only a narrow strip of this set of rings is formed. The rings then appear as short sections of arcs and may be photographed on a moving film as distinct parallel lines. Any movement of the diaphragm, however, causes a change in the air space between the quartz plate and the steel, which makes an amplified movement at the sections of arc and a corresponding change in the lines recorded on the moving film.

In practice, the quartz backing piece is ground to produce approximately 50 fringes. Since a deflection of about one-tenth of a fringe can be measured on the film, the displacement of the diaphragm can be measured to about one part in 500.

As long as the deflection of the diaphragm stays well below the elastic limit of the steel or quartz used, it is strictly proportional to the pressure applied. The number of fringes from

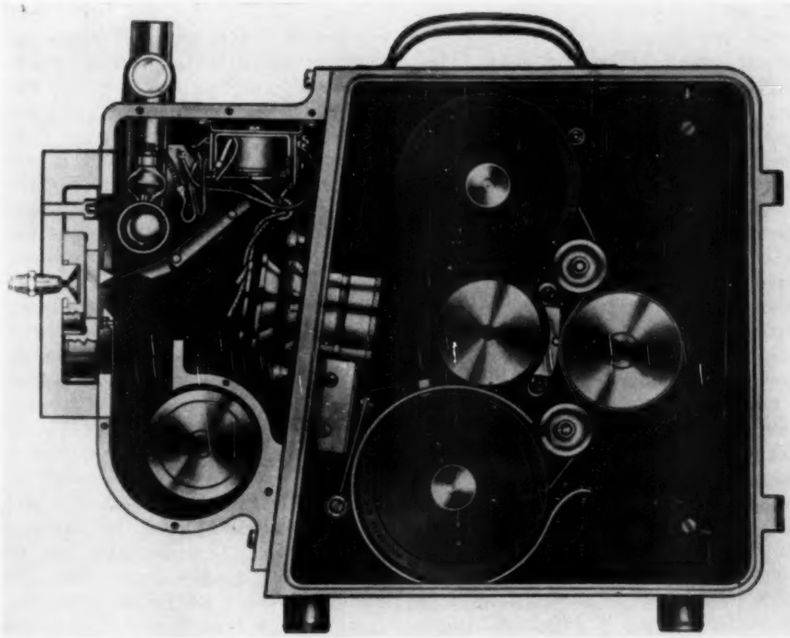


Fig. 2. Cutaway of first self-contained model of interferometer gauge.

the outer ring, which is in contact with the diaphragm, to the center of the diaphragm is directly proportional to the distance from the center of the diaphragm to the quartz backing plate; therefore, the number of fringes counted on a photographic film is directly proportional to the pressure applied. This linear relationship is, of course, a highly desirable feature for ease of calibration and interpretation of records.

Camera Details

The camera proper is of the familiar continuous moving film variety, but the special features of various models which have been developed should be mentioned.

The general scheme for film transport is the same on all models, and consists of a high-speed motor directly coupled to the take-up spool. The speed of the motor is controlled by a governor which is mounted on an idler drum driven by the friction of the film being pulled over it. Thus the motor speed is varied to give a constant film speed as the take-up reel increases in size. On most models the film speed can be controlled from 10 to 80 ft/sec. The supply spool has an adjustable drag to keep tension on the film which supplies driving power for the governor and to keep the film in the image plane. One model which was intended for short runs has a magnetic fluid brake[3] on the take-up reel which is supplied with power as soon as the driving motor circuit is broken. This camera will make as many as ten runs on a 100-ft spool of film at 80 ft/sec, and have the major part of each run at full speed.

One model is equipped with a footage counter which reveals the amount of

film left in the camera, and has a dial which can be set for the required film length in the next run.

Figure 2 is a cutaway drawing of the first self-contained interferometer gauge ever built. It was designed to measure the internal pressure of rocket motors in the range of 0 to 2000 psi. To keep the hot gases of the rocket motor from destroying the diaphragm, the pressure is conducted to the diaphragm by a short oil line. By choosing the proper viscosity of oil and the proper size of line, the diaphragm can be critically damped. The oil line then acts as a low-pass filter so that the frequency response of the system is the frequency response of the oil line itself. By keeping the line short and making sure there is no air in the system, the frequency response can be held above 10,000 cycle/sec. In the lower left corner of Fig. 2 is a blower fan used to keep the light cool. This is necessary because approximately 100 w of power must be consumed to get a sufficiently bright source. Between the two film spools is a slotted disc which is driven by a synchronous motor and puts timing marks on the edge of the film by interrupting the main light beam. The slots in this drum are of varying depths giving 5, 10 and 20 millisecond marks with increased lengths of line in each case to assist in analyzing the film.

In the center of the camera and next to the film frame is a holder for a small cylindrical lens. This lens is not shown in the optical diagram (Fig. 1) as it is not an essential component, but it does serve to reduce the size of the image of the slot on the film, thus increasing the frequency response that can be read for any given film speed. Mounted with its roller on the take-up spool is a microswitch which is operated by the increasing diameter of the take-up spool. This switch interrupts the current to the drive motor and applies energy to the brake on the supply spool.

Figure 3 is a picture of a model that was intended primarily for measuring pressures in blast waves, although it has proven to be a versatile camera and has been put to many other uses. The plate marked "Mounting for Quartz Diaphragm" is mounted flush with the surface over which the shock wave travels. This may be either the inside of the shock tube or the surface of the ground, as the experiment requires. The main features of this design are its ease of construction and its ruggedness. It is, of course, designed to stand the jars that it will receive when measuring shock waves. As in all very high speed cameras, there is a problem in keeping the end of the film intact as the driving motor comes to a stop. If the film is allowed to run free, approximately 1 in. is snapped off on every revolution, and at approximately 10,000 rpm, an appreciable section of the film can be destroyed in a very short time. To prevent this loss of record, two precautions have been taken. One is the microswitch which cuts off the power when the reel gets full, and the second is the two spring leaves which can be seen on either side of the take-up spool. These leaves are mounted so that, as the spool gets full, the film bears against the springs and acts as a brake to bring the motor to a stop in a very short time. With these two precautionary measures in operation the film can be used to within a few feet of the end of the spool without fear of losing a record.

Figure 4 shows the latest 16mm camera design. It is intended to measure pressures in free air or anywhere else that a small size is important. The camera model shown in Figs. 2 and 3 has self-contained power supplies and needs only to be supplied with 110 v a-c and a starting signal. However, this latest camera requires an external power supply as well as a starting signal. As can be seen from the picture, the case is extremely rugged and will stand pressures of 100-lb shock without being

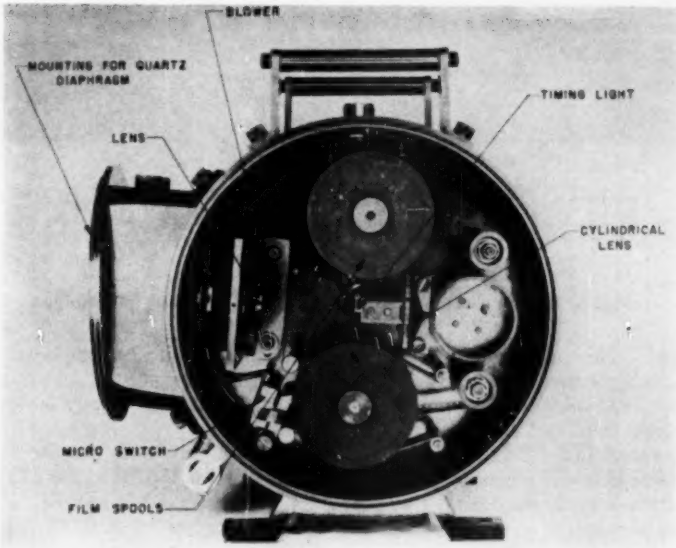


Fig. 3. Interior of model designed for blast-pressure measurements.

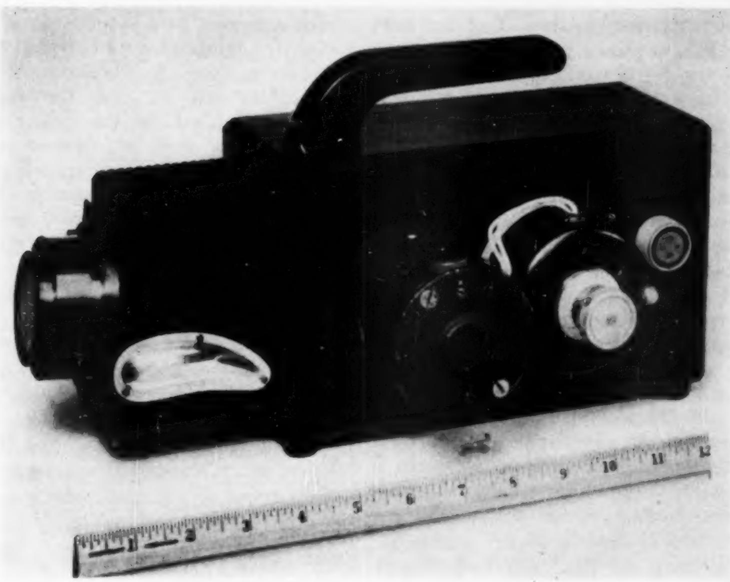


Fig. 4. Compact 16mm interferometer gauge.

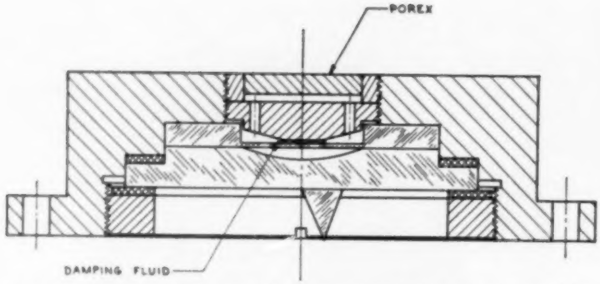


Fig. 5. Drawing of quartz diaphragm and damping assembly.

damaged. The diaphragm assembly shown in the extreme left is easily detachable, and diaphragms varying in range from 3 psi to 50,000 psi can be quickly substituted. This makes a single instrument that can record the pressure wave from a hand clap as well as the internal pressures of our largest rifles.

Diaphragm Construction

For pressures in the range of 3 to 100 psi it is possible and desirable to use a quartz diaphragm instead of the steel diaphragm shown in Fig. 1. Figure 5 is a drawing of this diaphragm assembly.

Fused quartz is an almost ideal material for a pressure diaphragm. Its ratio of Young's modulus to density is high, thus allowing a high natural frequency for a given pressure range. Fused quartz also has one of the smallest temperature coefficients known, and consequently its calibration is almost independent of temperature. The most interesting feature of the quartz diaphragm, however, is its ability to be optically contacted with another piece of fused quartz. This property allows us to build a diaphragm and a backing plate optically contacted together to form a single integral unit. This system is so stable that it requires only one careful static calibration for the life of the instrument.

To sum up the features of this assembly, we have the following characteristics:

1. High frequency response for a given pressure range.
2. A negligibly small temperature coefficient.
3. A stability that permits a single calibration for the life of the gauge.
4. No detectable hysteresis.

Damping

This quartz diaphragm, with almost perfect elastic properties, will vibrate at its natural frequency for a long time when subjected to a shock wave if not properly damped. One of the most difficult problems in the design of this instrument was to find the proper damping method for the quartz diaphragm. All sorts of schemes were tried, but all systems that gave adequate damping loaded a diaphragm so much that they reduced its natural frequency two or three times. This, of course, was highly undesirable, as one of the main features of the gauge is its high frequency response. Finally, almost by accident, it was found that if the direction of motion of the damping fluid was at right angles to that of the diaphragm, the mass of the damper did not add to the mass of the diaphragm and hence the frequency response was not destroyed. To accomplish this damping it was only necessary to bring a rigid metal support close to the front surface of the diaphragm in such a way that a drop of the proper viscosity fluid could

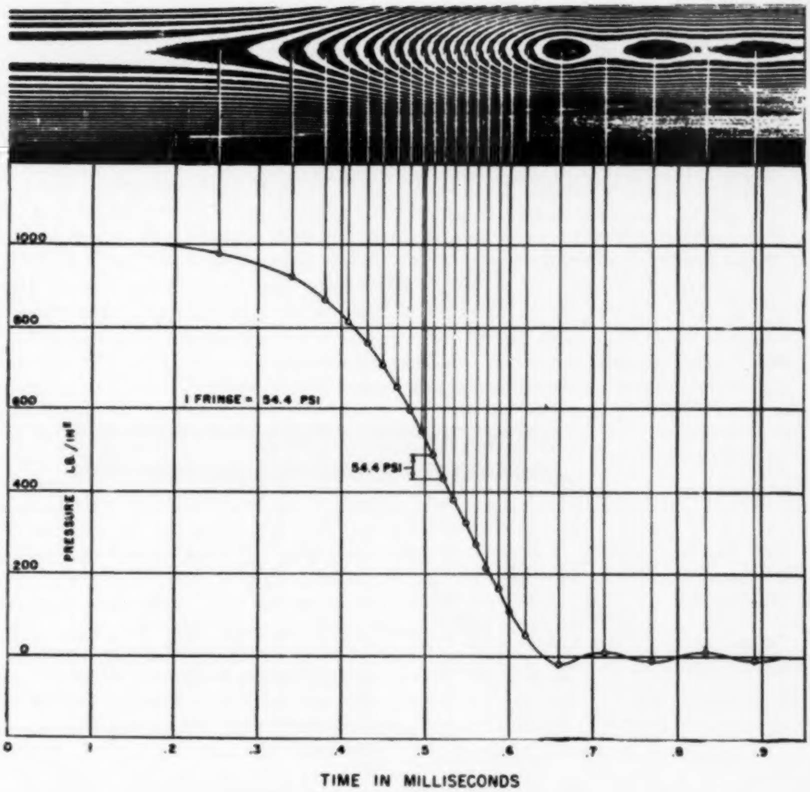


Fig. 6. Enlargement of an original record and method of plotting pressure-time curve.

be placed between the diaphragm and the metal support.

As the diaphragm deflects, the oil must flow along the face of the diaphragm to accommodate the change in volume between the diaphragm and the metal support. Damping is caused by the viscosity of the oil. Decreasing the clearance between the support and the diaphragm will increase the velocity of the oil and hence its damping action. A 0.040-in. diaphragm with a pressure range of 0 to 70 psi is critically damped if a 1000-centistoke oil drop is used with a clearance of about 0.004 in.

Figure 5 also shows the diaphragm damper and filter unit combination. The damping fluid is held in place between the metal plate and the diaphragm by its surface tension. After several months of field use, diaphragms have been inspected, and the oil drops have been found to be intact and damping properly.

As these gauges are intended for field use of the most exacting kind, it was found necessary to put a water and dust filter over the diaphragm proper. The material used for this filter has the trade name "Porex." It is manufactured by

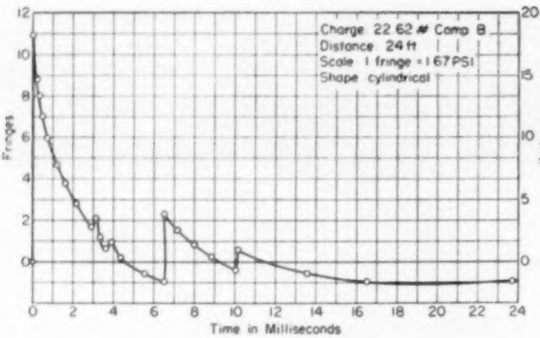


Fig. 7. Blast-pressure curve of small charge showing three separate shocks arriving at gauge.

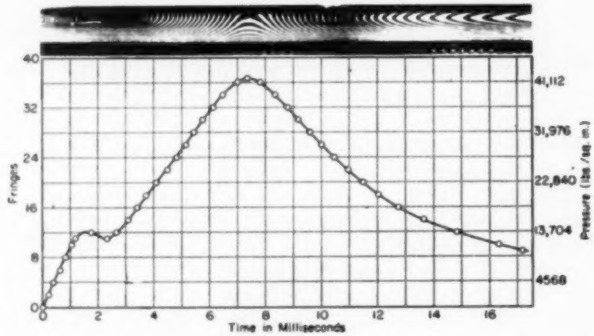


Fig. 8. Pressure-time plot of internal pressure developed by a typical large-caliber rifle.

Moraine Products Division of General Motors Corp. "Porex" is made of a large number of small beads which are bonded on their outer edges by heat and pressure until the whole unit is quite rigid but leaving a fair percentage of air passage between the balls. The "Porex" after manufacture is dipped into hot paraffin and the excess paraffin blown out with compressed air. This leaves each individual ball coated with a very thin layer of paraffin which will not be wet with water droplets. A "Porex" filter thus treated will not pass water even though it is immersed one-quarter inch or so. A blast gauge thus protected can be left out in the dust and rain even though its sensitive diaphragm is turned up flush with the ground. By keeping the volume of air small and the area of the "Porex" disc large, the flow time is so rapid that it does not measurably decrease the frequency response of the diaphragm.

Records

It is difficult to find a practical record that can be displayed on a magazine page, as most events of interest are a number of milliseconds long and would require many feet of paper to present them adequately. The record of Fig. 6

was chosen because the whole event could be shown on a single sheet of paper. This figure not only shows an enlargement of the original record, and the graph of pressure vs. time obtained from it, but also shows the method of plotting this curve. The record is of a small-volume hydraulic reservoir that is carefully filled with oil to exclude all gas pockets. The pressure is raised to 1000 psi as read on a dead-weight tester, and a quick-acting valve then releases the pressure to atmospheric.

The most satisfactory way of reducing the data of the film to a curve is to have a two-man team. An experienced man can read points off the film as fast as his partner can plot them on a piece of graph paper. With this system an average curve can be plotted in approximately 15 min. This type of rapid plotting allows one to achieve an accuracy of within about 0.5%. If higher-accuracy plots are desired, a more elaborate technique must be employed requiring some careful measurements of the fringe spacing. The accuracy obtainable by this gauge is not a function of the mechanics of the diaphragm but is determined by the accuracy of the original calibration and the accuracy with which the film can be read. To date we have never had an application in which the highest possible accuracy was required. We, therefore, have no data on what ultimately might be obtained.

Figure 7 is a blast-pressure curve taken with the gauge shown in Fig. 3. This shot was taken on an asphalt apron that was level and dust-free. The diaphragm of the gauge was mounted flush with the surface of the apron and at a 24-ft air-line distance from the explosive. The explosive was a 22.6-lb cylinder of Composition B suspended in the air by a small string and having its cylindrical axis at right angles to the line of measurement. It was detonated simultaneously in the center of each end of the cylinder. The record shows clearly three separate shocks arriving at the gauge. These shocks are probably due to the interreaction of wave fronts from the cylindrical and flat sections of the charge, respectively. The secondary shock fronts are a function of the orientation of the cylindrical charge as well as the distance of the gauge from the point of explosion.

Figure 8 is the first part of a pressure-time plot of the internal pressure developed by a large rifle such as the Navy uses on shipboard. This record is presented to emphasize two points: one, the extremely high pressures which the gauge is capable of measuring accurately; and two, to show how easily the gauge handles the time resolution of events that we normally think of as being very rapid.

Reference

1. W. E. Buck and W. H. Barkas, "Dynamic pressure measurement by optical interference," *Rev. Sci. Instr.*, *19:* 678–684, Oct. 1948.
2. W. H. Barkas and W. E. Buck, "Interferometer gauge," U.S. Patent Office, No. 2,591,666, Apr. 8, 1952.
3. Robert C. Mack, "Magnetic fluid clutch of unique design," *Automotive Ind.*, *98:* 38, 1948.

Discussion

Morton Sultanoff (*Terminal Ballistics Laboratory, Aberdeen Proving Ground, Md.*): By the appearance of the gauge, I would assume you are measuring the reaction of gauge material to the shock. How do you correct back to the actual shock from the response of the gauge material?

Dr. Buck: The quartz diaphragm actually responds to the shock profile within the limitations of its frequency response which is 10,000 to 100,000 cycles per second depending upon the pressure range used. The diaphragm does not, however, follow the shock exactly, as the shock pressure rises in much less than one hundred thousandths of a second. A pressure-time curve plotted with points every tenth of a millisecond would not see an error between actual and measured values, but if these points were plotted

at one hundredth of this spacing, a definite discrepancy at the shock front would be evident.

Kurt Stehling (Bell Aircraft): The question I have is your application to rocket motors. Do you use a microdensitometer? If so, you have several miles of film. The second question I have is, did you say the quartz is semialuminized on its surface?

Dr. Buck: Yes. If the quartz is not semialuminized, the fringes are very difficult to photograph, but if it is aluminized to the proper reflectance, the contrast between light and dark fringes is high, so that it is very easy to photograph.

In answer to your first question. I have not had an application where the accuracy required warranted the use of a microdensitometer. Reading quickly by eye an accuracy of 0.5 per cent is easily obtained. By using a microdensitometer the reading accuracy could probably be pushed well beyond this point.

Mr. Stehling: I was not thinking so much of the accuracy as the ability to take this data and feed it to a computer or card system, an IBM system.

Dr. Buck: We have not tried to use a card system as points can be read from the film about as rapidly as they can be copied down. A normal shock wave curve such as shown in this paper takes about 15 minutes to plot.

Amy E. Griffin (U.S. Naval Ordnance Test Station, China Lake, Calif.): I would like to make a comment that there are quite a few machines that have been developed in the last few years for analyzing records of this type, in which you have a motor control to transport film over to a certain position so that the operator can get the image by feeding a film—it can be fed automatically into a computer at the same time for further computations.

Kenneth Morgan (Interchemical Corp.): I do not quite understand how you obtained the original calibration so that you know what distance corresponds to what pressure.

Dr. Buck: We had a great deal of difficulty proving that a static calibration was equivalent to a dynamic one; however, through numerous tests such as comparing a static calibration to the peak pressure in a shock wave as measured by velocity gauges, we have gradually accumulated enough data to convince almost anyone. Once you have established the equivalence of a static and dynamic calibration it is simple to get as accurate a static calibration as required. The pressure element is clamped onto a pressure chamber and subjected to various pressures as measured by a dead weight tester. A short section of film is run for each pressure and a curve of pressure against fringe change plotted.

Optimum Slit Height in Photographic Sound-Track Reproducers

By W. K. GRIMWOOD and J. R. HORAK

For a specified reproducer frequency-response characteristic, there exists an optimum slit height. The optimum slit height depends upon the relative amounts of shot noise from the photosurface and thermal noise from the amplifier circuits. Calculated and measured values of optimum slit height are presented. The slit height which minimizes noise is undesirably large. Shot and thermal noise levels may be ignored if the d-c voltage drop across the effective phototube load resistor, without film in the light path, is of the order of 300 mv or higher.

The term "optimum" when applied to the height of the scanning slit in a photographic sound-track reproducer can be variously interpreted. One interpretation appearing in the literature of the subject is the slit height which gives maximum signal output at an assigned frequency,[1] another is that slit height which results in maximum ratio of signal-to-phototube noise at an assigned frequency.[2] The definition of "optimum" taken as the basis for this paper is that value of slit height which gives maximum signal-to-system noise ratio for a specified frequency-response characteristic as measured from film modulation to amplifier output. Film noise plays no part in the determination of optimum slit height. The effective size of the scanning beam is determined, not by the optical slit image, but by the overall response of the system. Since the reproducer frequency-response characteristic is fixed, the *effective* slit height is fixed. The reasonable assumptions are made that all phototube noise is shot noise and that all amplifier noise is thermal noise arising in the input coupling circuit. Both sources of noise have, therefore, the spectral distribution of "white noise" before any frequency discrimination is encountered.

The reproducer frequency-response on which are based the calculated and experimental data in this paper is one of the Standard Electrical Characteristics for Theater Sound Systems[3] specified by the Motion Picture Research Council (Fig. 1). The same set of curves have been proposed as standards for 16mm review rooms.[4]

Communication No. 1514 from the Kodak Research Laboratories, by W. K. Grimwood and J. R. Horak, Kodak Research Laboratories, Eastman Kodak Co., Rochester 4, N.Y., presented by J. R. Horak on October 10, 1952, at the Society's Convention at Washington, D.C.

Since the Standard Electrical Characteristics do not extend higher than 8000 cycles/sec, this frequency has been taken as the cutoff frequency for convenience in expressing slit height as a ratio to the cutoff wavelength, λ_c. Because the electrical response cannot suddenly cease at 8000 cycles/sec, the equalizer curves of Fig. 2 have been carried beyond this frequency at a rate of loss which appears reasonable and practical. High-frequency discrimination by electro-acoustic and acoustic elements has not been included in the calculations. These factors, when known, can readily be taken into account. Their inclusion will theoretically shift the optimum slit height slightly in the direction of higher slits. Likewise no attempt has been made to include subjective factors which might weight the noise spectrum.

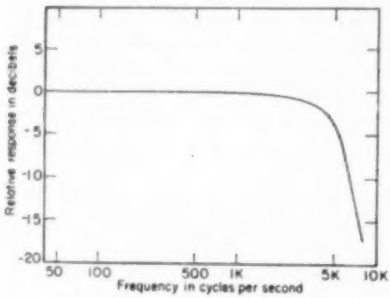
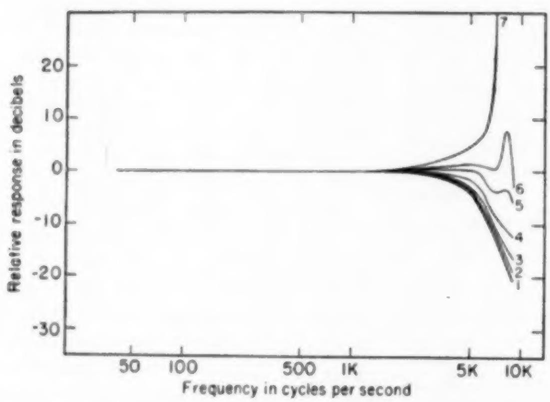


Fig. 1 Standard Electrical Characteristic.

Theoretical Optimum Slit Height

Consider a sound reproducer consisting of an optical system which projects on the film plane a sharply defined, uniformly illuminated scanning beam. The scanning beam impinges upon a film which has constant average transmittance and a percentage modulation which does not vary with wavelength. The light transmitted by the film falls upon a phototube which is coupled to an amplifier. The amplifier is considered to be so designed that constant percentage light modulation produces an output level, the frequency dependence of which is specified by Fig. 1. If the height of the scanning beam, h, is changed, the average light level upon the phototube and the average phototube current will change proportionately. The shot-noise power generated in the phototube is proportional to the phototube current. Thermal-noise power, arising in the coupling circuit, is constant per cycle of bandwidth for a fixed temperature.[5,6] For frequencies



Curve	h/λ_c
1	0.133
2	0.318
3	0.477
4	0.634
5	0.823
6	0.938
7	1.111

h = slit height,
λ_c = wavelength at 8000 cycles/sec.

Fig. 2. Equalization required to match Standard Electrical Characteristic.

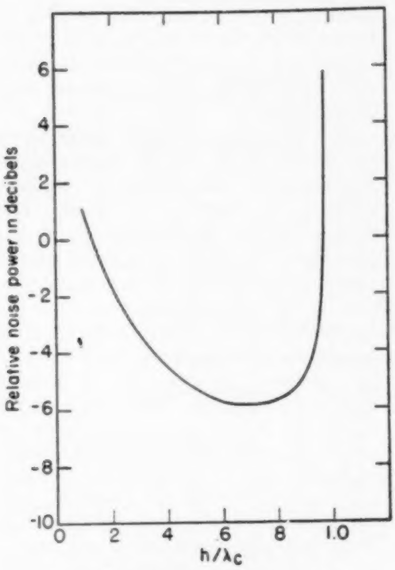


Fig. 3. Shot-noise power vs. h/λ_c.

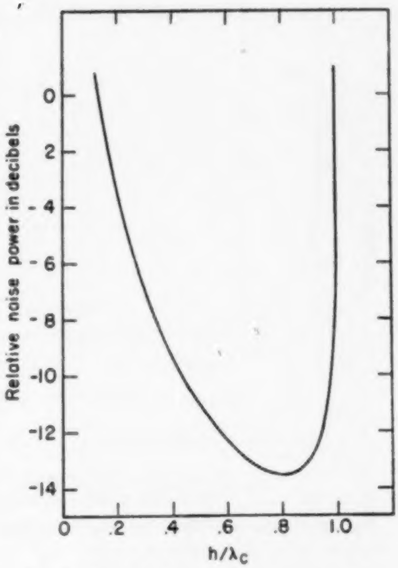


Fig. 4. Thermal-noise power vs. h/λ_c.

where the height of the scanning beam is small compared to the wavelength of the film modulation, the signal amplitude will be proportional to the scanning-beam height. Thus, in this frequency range, the ratio of signal amplitude to shot-noise amplitude will be proportional to the square root of the slit height. The ratio of signal amplitude to thermal noise will be directly proportional to the slit height.

At frequencies where the slit height is an appreciable fraction of the modulation wavelength, the signal amplitude will also be a function of frequency.[7] Since the overall frequency response has been specified, the product of the frequency discrimination due to the slit height and the frequency discrimination due to amplifier compensating equalizers must remain fixed. The necessary amplifier-frequency characteristics, plotted with decibel ordinates, are shown in Fig. 2. These equalizer characteristics distort the frequency spectra of shot and thermal noises. Because of the frequency characteristics of the amplifier equalizers, both noise levels will be functions of slit height. The rms noise voltage must be determined by integration of noise power per cycle over the frequency band of the amplifier. This may be done graphically by plotting the equalizer characteristics as the amplitude squared *versus* the frequency, measuring the areas under these curves and taking the square roots of the areas. Each such calculation gives the noise voltage, either shot or thermal, associated with a particular ratio of slit height to wavelength. Signal-to-noise ratios *versus* slit height-to-wavelength ratio can now be plotted. Figure 3 is a plot of shot noise in decibels *versus* the ratio of slit height to wavelength at cutoff. Figure 4 is a similar curve for thermal noise. In both figures, the noise levels are referred to an arbitrary fixed signal level at the amplifier output.

Minimum noise level occurs at slightly different h/λ_c ratios on the two curves of Figs. 3 and 4. The minimum

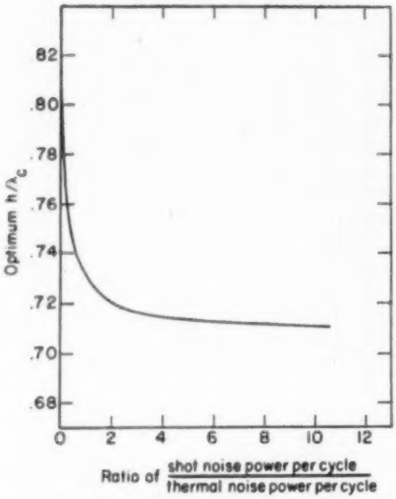


Fig. 5. Optimum h/λ_c vs. noise-power ratio.

total noise must be at an h/λ_c ratio between these two minima. The optimum slit height will thus be a function of the ratio of shot noise to thermal noise. The individual noise components can be added vectorially for various assumed ratios of shot noise to thermal noise, and the total noise plotted against h/λ_c, with noise ratios as a parameter. The locus of the minimum of this family of curves may then be plotted as optimum h/λ_c *versus* the ratio of shot noise to thermal noise, as in Fig. 5.

It has been shown[5,8] that shot noise and thermal noise are equal when the product of the average phototube current by the effective* phototube load resistance is 50 mv. This relation may be used to plot shot noise-to-thermal noise ratio *versus* the average voltage across the phototube load. Combining this information with the data of Fig. 5 results in the curve of Fig. 6 in which optimum h/λ_c ratio is related to millivolts drop across the phototube load resistance.

The preceding relations apply when the phototube is a simple vacuum type. The results are modified in two respects when gas phototubes are used. The high-frequency discrimination of gas phototubes modifies the spectral distribution of the phototube shot noise relative to the spectral distribution of the amplifier thermal noise since the frequency discrimination arises in the phototube prior to the source of the thermal noise. Calculations have been made taking this factor into account, with the result that the effect of gas-phototube frequency discrimination is one of negligible magnitude in the determination of optimum slit height. The second effect of a gas phototube is to multiply the ratio of shot noise to thermal noise by the gas amplification factor. Thus, the millivolt scale of Fig. 6 must be divided by the gas amplification factor when this curve is applied to gas phototubes. This same effect would apply were a photomultiplier tube to be used for sound reproduction. The obvious practical effect of using a photomultiplier tube would be the elimination of thermal noise, so that only the curve of Fig. 3 would be pertinent.

Measured Optimum Slit Height

Measured data were taken using a 16mm sound-film reproducer designed some years ago by J. G. Streiffert, of these Laboratories. This machine is well adapted to measurements with various slit heights by virtue of its double-slit optical system with a series of interchangeable secondary slits. An 8.5-v, 4.0-amp lamp and conventional sound-reproducer optical system are used to form a slit image, approximately 1.2 mils in height, at the film plane. The slit image at the film plane is enlarged 6.5 times by a microscope objective and

* Whereas the d-c voltage is developed across the phototube anode resistor, the noise components appear across the effective a-c load impedance in the anode circuit.

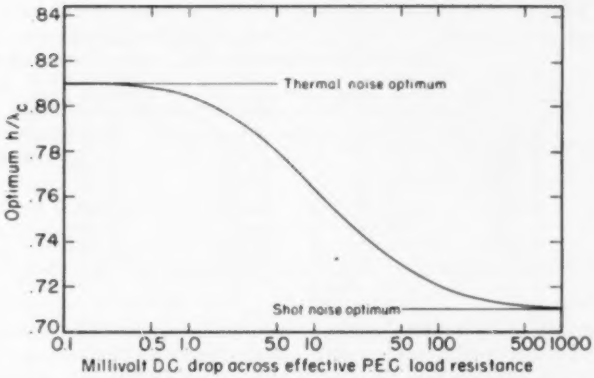


Fig. 6. Optimum h/λ_c vs. coupling resistance voltage drop.

imaged onto a secondary slit. A motor-driven chopper is inserted in the light path between the microscope objective and the secondary slit to provide a reference signal level for calibration purposes. The chopping frequency is approximately 200 cycles/sec. Radiation passed by the second slit is collected by a lens which images the objective lens onto the phototube surface. The phototube is a Type 927 (S-1 surface) operated at 52 v. This subnormal anode voltage is used because frequency discrimination due to the gas-amplification factor was found to be negligible at this voltage level. The phototube load resistor of 2 megohms is also the grid resistor of the amplifier. The amplifier is followed by a series of filters and a vacuum tube voltmeter. For each of the seven available secondary slits, the amplifier was separately equalized by an adjustable equalizer in the feedback path so that the overall response, as measured at the voltmeter position by means of a calibrated frequency test film, approximated the response curve of Fig. 1. The maximum spread between the seven response curves is 0.7 db from 50 to 7000 cycles/sec, increasing to 2.1 db at 8000 cycles/sec. The maximum deviation between the group of seven measured responses and the standard curve of Fig. 1 is within the limits of +0.8 db and −0.4 db from 50 to 7000 cycles/sec. Above 7000 cycles/sec, the measured responses drop more rapidly than the design objective; at 8000 cycles/sec, the extreme deviation is −6.1 db. Above 8000 cycles/sec, the electrical response drops very rapidly so that, in spite of the equalizing required for the largest slit, the noise components above 9000 cycles/sec are negligible. All noise measurements are made with a 500-cycle/sec high-pass filter in order to remove any hum components present. This filter is removed when measuring signal levels. The noise level with the amplifier input shorted is 20 db below the noise level with the normal input condition. This measurement is for a 200-cycle/sec bandwidth centered at 8000 cycles/sec; at lower frequencies, the noise with a shorted input is a few decibels lower.

The theoretical noise *versus* slit height curves are based upon the assumption that the slit is perfect, that is, the boundaries are sharply defined and the illumination is perfectly uniform over the entire image area. Since, in practice, this condition is rarely satisfied, it is necessary to define an "equivalent slit height." Equivalent slit height is that value of slit height determined by matching a measured amplitude-wave-

Table I. Slit Image Heights and Relative Illuminance Data

Slit height at film plane		Relative illuminance in db		Correction factors in db	
Calculated	Equivalent	Theoretical	Measured (avg.)	Signal level thermal noise	Shot noise
0.127	0.127	0	0	0	0
0.290	0.300	7.47	7.82	−0.35	−0.18
0.447	0.432	10.63	12.77	−2.14	−1.07
0.605	0.490	11.73	15.18	−3.45	−1.73
0.861	0.600	13.48	16.10	−2.62	−1.31
1.047	0.735	15.26	18.25	−2.99	−1.50
1.180	0.870	16.72	18.80	−2.08	−1.04

length curve with the theoretical amplitude-wavelength curve of a perfect slit. The values of slit heights which are used here in plotting measured noise levels have been determined by this technique. The precision of determining slit height from slit-loss data becomes rather poor for very small slit heights, since it was not practical to make measurements at wavelengths of much less than 1 mil. However, measurements of the light distribution along the height of the image of the primary slit show that the uniformity is very good for the smaller values of secondary slit height when the secondary slits are properly aligned with respect to the primary slit image. At the smaller slit sizes, the equivalent slit height approaches the value determined by dividing the measured height of the physical secondary slit by the magnification. For the smallest value of secondary slit, this calculated value is used since it is corroborated by the equivalent slit-height data.

The theoretical curves are also computed on the assumption that the illuminance upon the phototube is proportional to the slit height. Measurements show that this assumption is not, in this instance, justified. Although the data are consistent within each slit height, there are inconsistencies between the series of data for the several slits due to factors such as the necessary realignment of optics when changing slits, adjustments of lamp position for minimum microphonics, etc. From the relative illuminance data for the several slits, appropriate correction factors are determined which are applied to all signal and noise level data. Table I gives the slit image heights, relative illuminance data, and the correction factors.

For each of the seven slits, a series of measurements were taken of signal levels for both chopped light and calibrated film, film noise level, phototube noise level, and amplifier noise level. Nondiffusing neutral densities placed in the light beam ahead of the phototube were used to control the ratio of phototube noise to amplifier noise. The illuminance at the phototube, with the smallest slit in place and no density or film in the light path, was such that phototube noise was 7 db above thermal noise. Since the total noise level and the thermal noise level were known, the phototube noise level could be calculated. The correction factors of Table I were applied to these data, and all measurements were adjusted to a common signal reference level. The slit sizes are expressed as ratios of slit height to the wavelength corresponding to a cutoff frequency of 8000 cycles/sec.

The results are shown by the curves of Fig. 7. Curve A is the theoretical relation between shot noise and slit height taken from Fig. 3. The crosses are experimental points. Similarly, Curve B is the theoretical thermal noise *versus* slit-height relation of Fig. 4, the squares representing experimental data.

Curve C gives the relation between film noise level and slit height (signal level held constant) with measured values indicated by the circles. Note that the location of these curves on the ordinate scale has no significance. The absolute levels depend upon such factors as illuminance level, phototube sensitivity, phototube load resistance, film density, and film granularity. Accordingly, the experimental curves have been adjusted on the ordinate scale for best fit with the theoretical curves. A further check of the theoretical results may be obtained by making use of the relation between the phototube d-c output voltage and the ratio of shot noise to thermal noise. The measured gas-amplification factor (anode volts = 52) is 2.3, so that unity noise ratio should be obtained when the d-c voltage drop across the phototube effective load is 22.5 mv. The measured value is 23.8 mv.

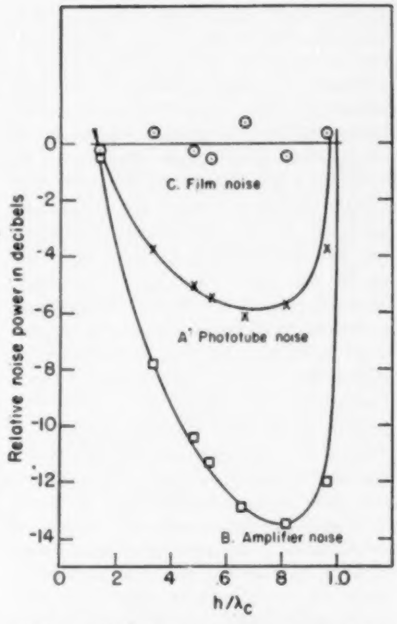


Fig. 7. Relative noise power vs. h/λ_c: ——— = Theoretical curves; ⊙, □, × = Experimental points; Curves adjusted to 0 db at $h/\lambda_c = 0.133$.

Discussion of Results

The optimum slit height for minimum electrical noise level is, from Fig. 7, some value of h/λ_c between 0.71 (minimum phototube noise) and 0.81 (minimum amplifier noise). Using the former value gives an electrical noise level not more than 0.4 db higher than the true optimum. An h/λ_c value of 0.71 gives actual slit heights of 0.64 mils and 1.60 mils for sound-reproducer speeds of 7.2 in./sec and 18 in./sec, respectively. The corresponding slit loss at a frequency of 8000 cycles/sec is 8.9 db. A slit loss of this magnitude is undesirable, partly because of the required equalizing, but chiefly because relatively small differences between actual slit heights and design value will cause appreciable changes in overall frequency response. If phototube noise is much greater than amplifier noise, there is considerable tolerance in the choice of slit height. Then h/λ_c may have values from 0.44 (at which value the slit loss is but 3 db) to 0.9 without increasing the noise level by more than 1 db.

Because phototube noise voltage is proportional to the square root of illuminance, the most adverse conditions, with respect to the ratio of phototube noise to amplifier noise, exist when noise-reduction sound tracks are used. The illuminance on the phototube during a silent portion of a noise-reduction track may be only about 5% of the illuminance with no film in the reproducer. Assuming the phototube to have a gas-amplification factor of 6 and no film in the light path, the d-c level across the effective phototube load resistor must be about 300 mv (this is equivalent to 106 rms mv for 100% light modulation, as by a sinusoidal light chopper) for phototube-noise power to be double the amplifier-noise power when a fully biased noise-reduction sound track is reproduced.

Under these conditions, the amplifier will still contribute about 2 db of thermal noise to the electrical noise level.

Film noise will ordinarily be well above phototube and thermal noise. Noise due to the granular structure of the photographic image may be 45 db to 55 db below the signal level. For phototube output levels at the magnitude specified in the preceding paragraph, the shot-noise level is likely to be 10 db to 20 db below the film-noise level, depending upon the film-noise level and the average luminance upon the phototube with film in the reproducer. A phototube output of 300 mv d-c, though not always attained even in 35mm projectors, is entirely feasible. A level of nearly 450 mv was measured on the equipment described above when operating with a gas-amplification factor of 2.3 and an equivalent slit height of 0.432 mils. The phototube should have as high an effective physical load resistance as is consistent with distortion requirements, since signal level and shot noise increase more rapidly as a function of the load resistance than does thermal noise.

Conclusion

It has been shown that the slit height giving maximum signal-to-electrical noise ratio in a photographic sound reproducer may be readily calculated. The necessary data are the desired overall frequency-response characteristic, the phototube gas-amplification factor, and the d-c voltage drop across the phototube effective load resistor at the illuminance level for which the noise is to be minimized. The optimum slit height so found is undesirably large. Phototube and amplifier noise levels become relatively unimportant, thus permitting wider choice of slit height, if the phototube d-c output level, assuming a gas-amplification factor of 6, is 300 mv or over, without film in the machine. An output level of this magnitude is readily attainable.

References

1. G. Logan, "Optimum response scanning slit-image," *Electronics, 15:* 140–143, June 1942.
2. J. C. Frommer, "The optimum width of illumination of the sound track in sound reproducing optics," *Jour. SMPE, 49:* 361–369, Oct. 1947.
3. Motion Picture Research Council, Inc., Technical Bulletin, "Standard Electrical Characteristics for Theater Sound Systems," p. 7, Apr. 20, 1948.
4. "Tentative Recommendations for 16mm Review Rooms and Reproducing Equipment," *Jour. SMPTE, 56:* 116–123, Jan. 1951.
5. J. B. Johnson and F. B. Llewellyn, "Limits to amplification," *Bell Sys. Tech. J., 14:* 85–97, Jan. 1935.
6. G. L. Pearson, "Fluctuation noise in vacuum tubes," *Bell Sys. Tech. J., 13:* 634–654, Oct. 1934.
7. N. R. Stryker, "Scanning losses in reproduction," *Jour. SMPE, 15:* 610, Nov. 1930.
8. W. A. Harris, "Fluctuations in space-charge-limited currents at moderately high frequencies, Part V. Fluctuations in vacuum tube amplifiers and input systems," *RCA Rev., 5:* 505–525, Apr. 1941.

Discussion

Maxwell A. Kerr (Navy Department, Bureau of Ships): What type of first tube was in your amplifier?

Mr. Horak: I had direct coupling between the phototube and my first amplifier tube and the first amplifier stage was a 12J5 cathode follower to lower the impedance feeding the long cable to the main amplifier.

Mr. Kerr: The reason I ask that is that these conclusions are based on what seems to be a cesium-type phototube. For instance, there are no measurements on the lead sulfide type, are there?

Mr. Horak: I have no measurements on lead sulfide tubes at all.

Mr. Kerr: I see. I just wondered if that wouldn't change the ratios on that curve.

Mr. Horak: If the same Standard Electrical Characteristic is maintained, and if the lead sulfide tube actually has a white

noise spectrum, and the noise varies with the light level in the same manner as shot noise, the curves would be correct. If the noise characteristics are known, the same method of computation can be applied to any type photocell. The character of the noise introduced by the lead sulfide tube may be different from that of shot noise and perhaps the absolute noise level would be greater.

Mr. Kerr: Except that our experience has been that the signal-to-noise ratio was much higher on the lead sulfide tube.*

Mr. Horak: I'm not too familiar with lead sulfide tubes, but I believe the noise level is perhaps a little higher and the signal level is much higher.

Mr. Kerr: That's right.

George Lewin (Signal Corps Photographic Center): Are the optimum values you have arrived at by this investigation radically different from practice in commercial projectors?

Mr. Horak: We measured one Eastman Model 25 Projector and it has a slit height of approximately 0.5 mil, which corresponds to an h/λ_c of about 0.55. This measurement was made without checking the focus and azimuth adjustments.

As I pointed out, the film noise is the dominant factor. If you have sufficient illumination on the phototube, it doesn't really matter, within wide limits, what slit height you have. The determining factors are how much do you want to equalize and how critical do you want your adjustments to be.

Anon: Can you manufacture projectors with these optimum slit heights?

Mr. Horak: These slit heights are within practical manufacturing ranges. The 16mm projectors need to have equivalent slit heights of between 0.64 and 0.73 mil.

The 35mm projectors have, I believe, a slit height of about 1.2 mils. The h/λ_c of 0.71 would be equivalent to 1.64 mils — that's the optimum for phototube noise — that would be 1.64 mils for the 35mm reproducers, and the standard is 1.2 mils. The standard was apparently selected on the basis of practical equalization rather than on the basis of minimum electrical noise level.

---

* Lowell O. Orr and Philip M. Cowett, "Desirable characteristics of 16mm entertainment film for Naval use," *Jour. SMPTE, 58:* 245–258, Mar. 1952. See especially p. 249, Use of Sulfide Photoresistive Cell.

Dual Photomagnetic Intermediate Studio Recording

By JOHN G. FRAYNE and JOHN P. LIVADARY

Selected production magnetic tracks are transferred to a recorder which lays down collinear 200-mil push-pull direct-positive variable-area and magnetic tracks. Magnetic stripe is on base of photosensitive emulsion on the opposite edge of film from photo track. The photo track may be used for reviewing, cutting, etc. Re-recording is done from assembled magnetic tracks. This method combines advantages of photo track for editing and provides superior quality of magnetic track. Certain operating economies are made possible by this method.

The use of magnetic recording for original motion picture production has made such great strides since its introduction into the studios three or four years ago that it has now become the almost universal medium for this type of recording. The use of magnetic recording in the subsequent studio operations, such as running of dailies, cutting, editing and re-recording, has been very limited to date. This hesitancy on the part of the studio has been due to many factors, some economic in nature, some imposed by the unavailability of the necessary tools—such as suitable film splicers—and some due to the inevitable inertia in changing over from certain time-honored work practices to new and untried techniques.

Presented on October 10, 1952, at the Society's Convention at Washington, D.C., by John G. Frayne, Westrex Corp., 6601 Romaine St., Hollywood 38, and John P. Livadary, Columbia Pictures Corp., 1438 Gower St., Hollywood 28, Calif.

Among the latter, the cutting and editing of the opaque magnetic sound track have been stumbling blocks to operators long accustomed to "reading" the visible modulations of either variable-density or variable-area photographic sound tracks. Attempts have been made to ameliorate this situation by superimposing so-called "modulation" writing on the magnetic coating, or, in the case of striped film, on the clear film base area. This writing usually represents a trace of the sound envelope (rather than the individual sound modulations) because of the difficulty of making the writing pen follow any but the lowest of the sound-track frequencies. Consequently, the output of the magnetic sound track is usually rectified before being fed into the pen, and with the aid of some electric filtering a d-c deflection may be obtained for even a high-

frequency input. This writing usually involves a separate operation, at a reduced speed, to obtain a legible trace.

The method described in this paper retains all the advantages of the standard photographic sound-track studio procedure and combines with it the improved quality and ease of operation associated with magnetic sound recording. This method also achieves from the very start the ultimate objective of using magnetic sound track for re-recording purposes. In this method the original magnetic sound track is transferred by re-recording to a special film consisting of a standard sound-recording photographic emulsion on which is coated a magnetic stripe, and which will be referred to in this paper as photomagnetic film. The location of the magnetic stripe is shown in Fig. 1, which also shows a 200-mil push-pull variable-area track. The latter is in the standard position for a sound-track print even though it is recorded as a direct-positive variable-area track. The magnetic track is in the No. 3 position on the Proposed American Standard PH22.86. The standard position for the direct-positive photographic track is obtained by reversing the film travel in a standard Westrex RA-1231 Recorder. The magnetic track may be reproduced by reversing the film travel in a standard single-track magnetic sound reproducer or in the normal forward direction in a triple-track reproducer.[1]

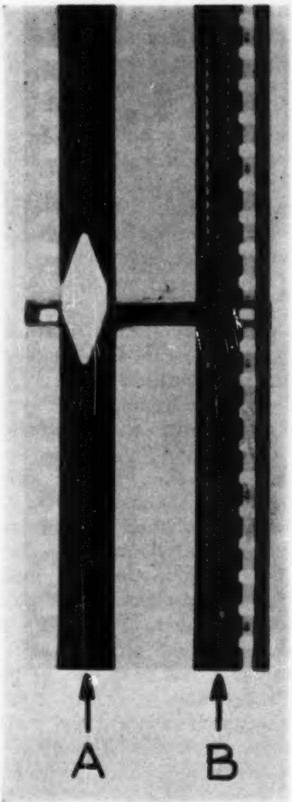


Fig. 1. Photomagnetic film sample: (A) magnetic stripe, showing bloop; (B) photo track.

Having obtained such a film, the photographic track may be used for running dailies and for the regular editing and cutting procedures. The magnetic track may, if desired, be used for dailies, although its primary function is as a re-recording medium. In cutting the sound film standard editing practices are followed on the photographic track, and, since the photographic and magnetic modulations are in exact juxtaposition across the track, a cut across the film insures correct synchronization for both tracks. This method of recording does not involve any drastic change of daily habits for the film editor occasioned by the reading of the magnetic sound track or in the proper interpretation of derived modulation-scribed tracks. Rather, it affords the editor the opportunity of gaining proficiency in the aural editing of magnetic tracks, guided by the parallel photographic track which is always available for reference.

With this technique, no capital investment is required to convert review rooms.

Moviolas or any other screening equipment to magnetic sound reproduction, since the regular photographic sound-reproducing equipment may be used to reproduce either the push-pull or one-half thereof as a standard single track. Only the re-recording equipment required for the final transfer to the release photographic equipment needs to be modified to reproduce from the magnetic track on the composite film.

Dual Recorder

The recorder chosen for this work was the Westrex RA-1231-C Variable-Area Recorder as modified to lay down a 200-mil push-pull direct-positive variable-area track as previously described in the *Journal*.[2] The optical schematic of the direct-positive variable-area modulator is shown in Fig. 2. It includes a check visual monitor and an improved photocell monitor. In the latter the ingenious scheme is employed of using the light transmitted through the ribbons for actuating the photocell monitor, the light reflected from the ribbons being used to expose the photosensitive emulsion.

The recorder was further modified by adding a magnetic recording kit similar to that described in the March 1950 *Journal*.[3] Since the film travel is in the reverse direction, the monitor head has been moved as shown in Fig. 3 to a position above the recording head, instead of to the customary position below and to the right of the latter. The location of the recording head at the drum position makes it possible to make the magnetic and photographic lines of translation exactly collinear. In fact, the location of the recording head at any other position in the recording machine would defeat the purpose of this dual-recording technique. One of the problems encountered in this recorder was the tendency to partial magnetization of the recording head by the stray field from the light-valve permanent magnet. This was somewhat alleviated by placing a sheet of mu-metal between the modulator and film compartments of the recorder. Under this recording condition, an overall signal-to-noise ratio of about 55 db is readily obtained on the magnetic track. Since this is considered satisfactory in view of the ultimate transfer to a standard photographic release track, no further isolation of the disturbing source of magnetization seems to be immediately warranted.

Film

The film used to date in this process is the Eastman Fine Grain Sound Recording Safety Film, Type 5372 (35 mm), variable-area type film with the magnetic stripe added to the base side of the photosensitive film. The pioneering work in the coating of this raw stock was carried out by Reeves Soundcraft Corp., and in spite of the rather hazardous process of working with a light-sensitive film the production of the early batches of the dual-purpose film has been singularly free of serious defects. Further experience should tend to make this operation a purely routine affair. The processing of the film is handled in the film laboratory without any precautions other than those dictated by normal operating practice for the proper development of variable-area tracks. No damage to the magnetic stripe by the photographic developing process has been observed.

The Record-Reproduce Transmission System

The transmission system of the photographic-magnetic transfer channel in use at Columbia Pictures Corp. is shown in block-schematic form in Fig. 4. The original magnetic recording is reproduced by a modified RA-1251 Re-recorder, the signal being fed to a dividing network through a level-control attenuator and line amplifier. The dividing network provides two input signals, one of which is recorded by

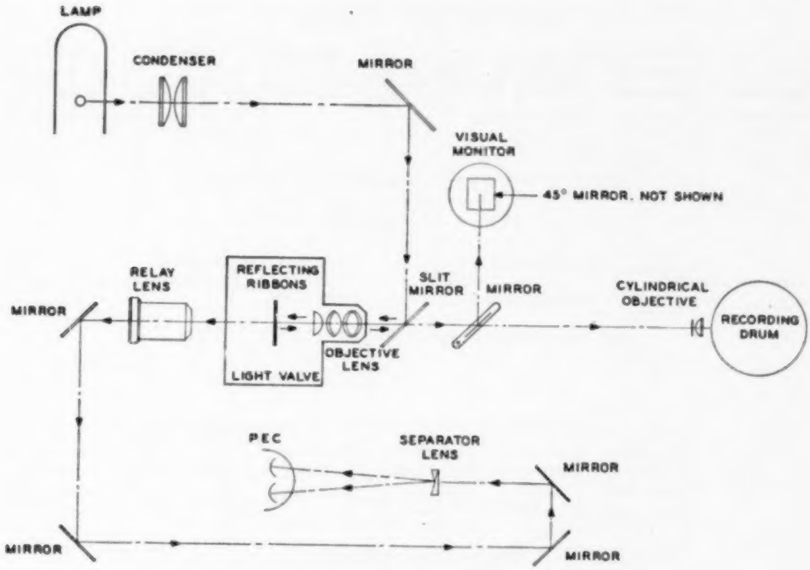


Fig. 2. Variable-area modulator optical schematic.

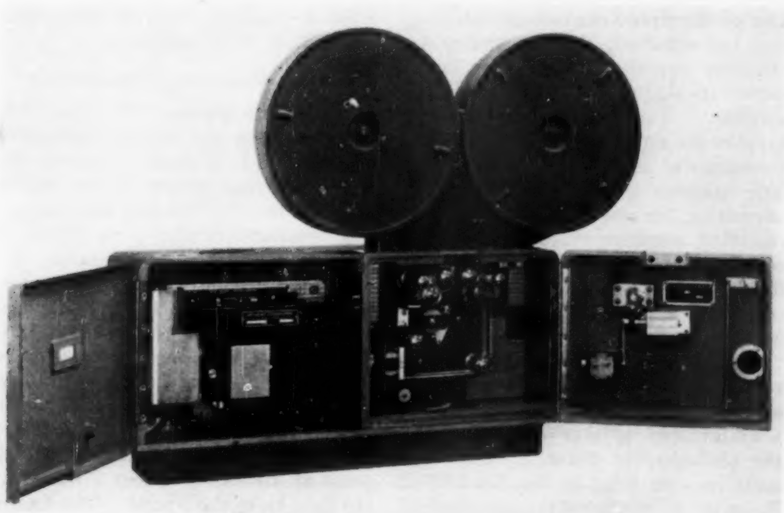


Fig. 3. Dual photomagnetic recorder.

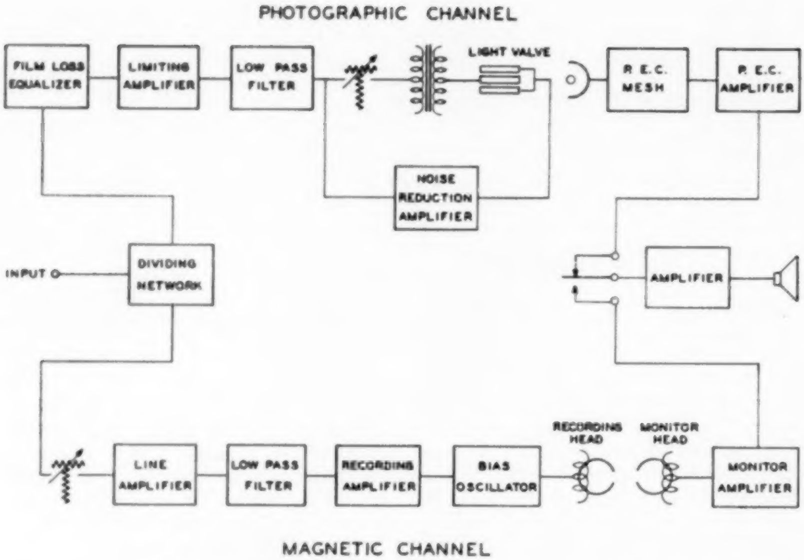


Fig. 4. Block schematic of dual recording channel.

the photographic channel, the second being recorded by the magnetic channel. The photographic channel consists of a film loss equalizer, limiting and peak-chopping amplifier, low-pass filter, light-valve attenuator and noise-reduction amplifier. This photographic channel supplies the signal for the photographic modulator of the RA-1231-C Recorder. The magnetic channel consists of an attenuator, line amplifier, low-pass filter, recording amplifier which also provides equalization, and a bias oscillator and filter. The magnetic channel supplies the signal for the magnetic recording head in the RA-1231-C Recorder.

The PEC mesh of the RA-1231-C Recorder is connected to an external amplifier which in turn feeds the monitor amplifier and speaker for monitoring the photographic channel. The magnetic monitor head in the RA-1231-C Recorder is connected to an external magnetic-reproducer amplifier which feeds the monitor amplifier and speaker so that the magnetic channel may be monitored. Suitable switching is provided so that the operator may select the channel to be monitored.

Recording Frequency Characteristic

Photographic Channel. The film loss equalizer plus the normal light-valve resonance rise is used to correct the frequency characteristic of the photographic channel. The film loss equalizer is so adjusted that when a constant level signal is recorded photographically, the resultant film will reproduce "flat" when referenced to the Research Council standard frequency film ASFA-2 5-521-A. The frequency response of the photographic channel from the input to the light-valve transformer is shown in Fig. 5. The film recording channel is so adjusted that the peak chopping point of the limiter occurs 1 db below the light-valve clash point. The limiter amplifier has a 20:1 ratio, the start of limiting being 2 db below the peak

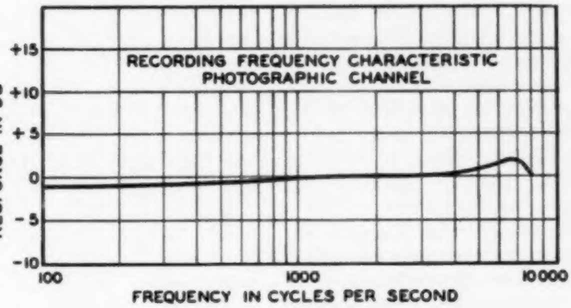


Fig. 5. Photo channel frequency characteristic.

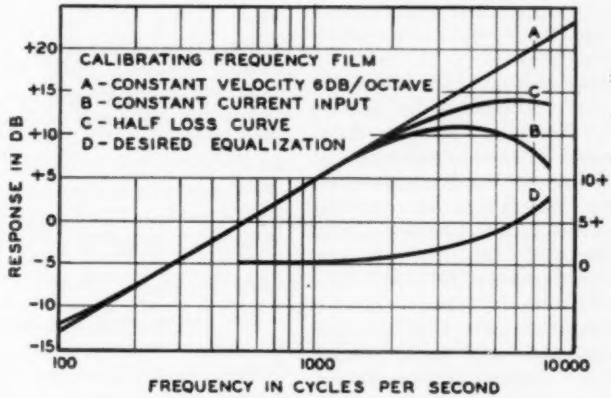


Fig. 6. Magnetic calibrating frequency film.

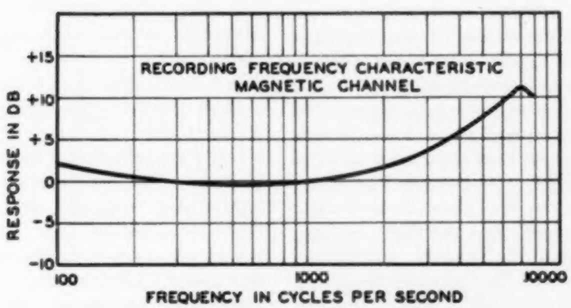


Fig. 7. Magnetic-channel frequency characteristic.

chopping point. During the transfer operation, signal level is so adjusted that peak signals are compressed approximately 4 db. Operating under the above conditions the distortion of the photographic track at a level just below the peak chopping point is 1.8% at 400 cycle/sec. and the signal-to-noise ratio is approximately 50 db.

Magnetic Channel. The magnetic recording channel is provided with low- and high-frequency pre-equalization in order to improve the signal-to-noise ratio of the magnetic track. The low frequency pre-equalization amounts to 5 db at 50 cycle/sec, this amount of equalization being based on the energy distribution of speech and music so that the magnetic film will not be overloaded at low frequencies.

The high frequency pre-equalization is adjusted to compensate for half of the overall film recording and reproducing losses. In order to determine the shape and amount of this equalization, a frequency film was recorded at normal bias current while maintaining constant audio current through the recording head. This frequency film was then reproduced over the same magnetic head by means of a flat amplifier using a high-impedance grid input, voltage amplifier and cathode follower output stage. The frequency film has a characteristic similar to that shown in Fig. 6. On this characteristic curve a constant velocity (6 db per octave) line A-B was drawn. It was then assumed that the deviation of the measured response from the constant velocity line was a measure of the recording and reproducing losses, such as slit reproducing losses, demagnetization, etc. The losses measured by this method were then divided in half and pre-equalization was introduced into the recording characteristic to compensate for one-half of the measured loss. In practice this equalization amounts to approximately 10 db at 8000 cycle/sec. After the high- and low-frequency pre-equalization characteristic had been determined by the above method, a standard three-track frequency film was recorded. This standard film was used to adjust all reproducer equalization to a common standard. The recorder equalization was then adjusted so that a magnetic film recorded on the photographic-magnetic recorder would reproduce "flat" on any of the calibrated reproducers. The frequency response of the magnetic recording channel from the input to the output of the recording amplifier is shown in Fig. 7.

The gain of the magnetic channel is so adjusted that the 1% distortion point at 400 cycle/sec of the magnetic film occurs for the same input signal which causes peak chopping in the photographic channel. Under these conditions, the signal-to-noise ratio of the magnetic track is approximately 55 db. This relatively low value of signal-to-noise ratio is due to the magnetic flux introduced into the recording head by the leakage flux of the permanent magnet of the light valve.

Studio Routines

This method was first introduced at Columbia Pictures on May 19, 1952. In order to study its effect upon normal editorial procedures, it was introduced without any forewarning to the editorial department. The only information transmitted to the film editor was to the effect that he should ignore the magnetic sound track and edit the photographic track in the usual manner. When he finished editing the first picture, the film editor commented that he objected slightly to reducing the transparent area adjacent to the normal photographic sound track by the application of the magnetic stripe. This reduced his field of vision while running the sound and action film superimposed and made it difficult for him to follow some of the action on the fringe of the picture frame.

During re-recording it was found that the quality of the magnetic stripe was a faithful copy of the original magnetic recording. Apparently the processing of the photographic sound track had resulted in no ill effects on the magnetic track, which confirmed pre-production tests during which the characteristics of the magnetic sound track were checked before and after film processing.

Normal overlap film splices were used in splicing this film. In running the magnetic sound track some of these splices proved to be silent and some noisy. It was found that magnetized shears and cutting blades of the regular film splicers were mostly responsible for this effect. It was also observed that certain splices had a microphonic effect upon the magnetic head due to the impact of the lower edge of the film splice upon the magnetic head.

This last observation revealed that film splices were silent when made in one particular direction, which luckily happened to be the normal way of making splices on photographic film.

The splice noise was eliminated by punching a diamond-shape hole (see Fig. 1) over the magnetic splice, as is done on photographic negatives. Another method was to notch the film at each splice and momentarily short-circuit the recording system by a microswitch operated from these notches. Still another solution involved the momentary lifting of the splice from the magnetic head by the application of a triangular piece of adhesive paper on the splice.

Some of the first samples of this photographic film exhibited severe edge-wave and spoking of the film roll. These defects have long been present to a minor degree in standard motion picture film but were apparently exaggerated in adding the magnetic stripe to the base of the sensitized film. They have been largely removed through the cooperation of the manufacturer of the striping process. Another difficulty, pressure densitization of the photographic emulsion, due to too tight winding of the film rolls after adding the stripe, was also present in some of the early samples. This defect, too, has since been eliminated by more careful attention to proper rewinding of the coated film.

The location of the balance stripe was also given some thought. Some film was manufactured with the balance stripe along the outer edge of the sprocket holes on the side of the photographic sound track. Other film was manufactured with the balance stripe located along the inner edge of the photographic sound track. Both positions were tried since at the beginning it was not quite clear whether the manufacturer's edge numbers on this film would be of any importance in film editing, and provision was therefore made to leave the edge numbers visible. Later, however, it was decided that these numbers had no particular significance and the balance stripe was moved to the outer edge of the film.

In projecting the photographic track on normal projection equipment, it was found that the thickness of the magnetic stripe caused a slightly out-of-focus condition which resulted in a loss of 1 db at 7,000 cycles. This was more evident when the balance stripe was placed adjacent to the photographic sound track because the magnetic stripe and the balance stripe were both riding the scanning drum, which caused the photographic film to be out of focus by the thickness of the magnetic emulsion. However, the later removal of the balance stripe to the outer edge of the film placed the photographic track in a more favorable position and practically eliminated this out-of-focus condition.

Benefits of the Method

The benefits derived by this method so far are as follows:

1. It eliminates the need for introduc-

ing magnetic equipment in the projection rooms.

2. It introduces 100% magnetic operation without causing any disturbance in the editorial department.

3. It eliminates photographic re-recording masters and substitutes a magnetic sound track for re-recording purposes.

Economic Considerations

Experience with this recording method at Columbia Pictures has shown that there is a definite reduction in cost as compared to the normal negative-positive photographic recording method as practiced at the studio. However, due to the downward trend in costs of magnetic striped film and also due to such alternate methods as the use of 17½mm instead of 35mm and the substitution of a lower-cost fine-grain positive for the premium 5372 emulsion, it is difficult to set down in figures what the ultimate savings might be in the method of recording described in this paper. A considerable saving results from the elimination of master photographic re-recording tracks which amounts to an average figure of $500 per picture at Columbia.

It is too early yet to thoroughly evaluate completely the full effect and future potentialities of this particular method. This method was originally developed as an interim measure designed to promote the gradual education of the film editors at Columbia Pictures in the handling of magnetic films prior to the introduction of 100% magnetic-recording methods. It is quite possible, however, that because of the advantages shown above this method may eventually develop into a strong competitor to the all-magnetic recording method which is the ultimate objective of the motion picture industry.

The authors wish to acknowledge the invaluable aid of Lloyd Russell of Columbia Pictures in getting this recording system into practical use in the studio. They also wish to thank Reeves Soundcraft Corp. for their cooperation in making this film available and in endeavoring to meet the particular studio requirements for the successful operation of this photo-magnetic film method.

References

1. C. C. Davis, J. G. Frayne and E. W. Templin, "Multichannel magnetic film recording and reproducing unit," *Jour. SMPTE, 58:* 105–118, Feb. 1952.
2. L. I. Carey and Frank Moran, "Push-pull direct-positive recording," *Jour. SMPTE, 58:* 67–70, Jan. 1952.
3. G. R. Crane, J. G. Frayne and E. W. Templin, "Supplementary magnetic facilities for photographic sound systems," *Jour. SMPTE, 54:* 315–327, Mar. 1950.
4. Eastman Kodak Company, *Common Cause of Damage to 35mm Release Prints*, 1952.

Discussion

J. E. Aiken (Naval Photographic Center): Many studios prefer the use of variable-density sound tracks. I would like to ask Dr. Frayne if there is any reason why this method may not be used with variable-density sound tracks. While I have the floor, I would like to ask a second question. What precautions should be taken in the film laboratory in processing and are any changes in techniques and equipment required in the film processing laboratory?

Dr. Frayne: There's no reason whatever why you could not use variable-density instead of variable-area, provided that you have a variable-density direct-positive. There was a paper published in the *Journal* about a month ago by O. L. Dupy, which I had the privilege of presenting for him at the Chicago Convention, in which is outlined a direct-positive variable-density system which is currently being used on an experimental basis at M-G-M. If that or some similar method works out, there is no reason why it cannot be used. The problems are the same for either method as far as equipment is

concerned. With regard to the second problem, all I know about the laboratory problem is that I have been assured by Mr. Livadary and the laboratory people at Columbia that no extra precautions have to be taken in handling this film in the laboratory. Does that answer your question?

Mr. Aiken: Thank you.

George Lewin (Signal Corps Photographic Center): Is this type of magnetic film fully as good as a regular full-width magnetic film in sound quality?

Dr. Frayne? I have been assured that the striped film now in production is of comparable quality. At first, I believe, there were some difficulties. I think that somebody in the audience from one of the film-coating companies could answer that question better than I can.

Edward Schmidt (Reeves Soundcraft Corp.): John, you're quite right. The early films did have problems. But I feel that the present product that we manufacture is equivalent to the current full-width 35mm magnetic film, without any question.

Dr. Frayne: Thank you.

Television Facilities of the Canadian Broadcasting Corporation

By J. E. HAYES

This paper describes the television stations which the Canadian Broadcasting Corporation has built in Montreal and Toronto for the inauguration of television broadcasting in Canada. In planning these stations certain special requirements had to be met such as the necessity for programming in two languages in Montreal and the need for producing a relatively large percentage of locally originated shows in both cities.

It might be said that the first official step in the development of a Canadian television service was taken in January 1950 when the Governor-in-Council approved a loan of $4,500,000 to the Canadian Broadcasting Corp. for the purpose of establishing television stations in Montreal and Toronto. Actually, of course, much work had preceded this action. We had kept in close contact with progress in England, France and the United States, and had prepared for our management detailed reports covering technical, program and financial aspects of television. The Board of Governors of the CBC was in a position therefore to make recommendations to the Canadian Government with a full knowledge of the existing television situation in other countries and the probable effect of its impact on Canada.

Detailed engineering work was started immediately and a position of Coordinator of Television established to ensure coordination of the planning of the program, engineering, policy and financial aspects of the project. The duties of this post were undertaken by J. A. Ouimet who was, at that time, Chief Engineer. Appointments were made of the key personnel for both the Montreal and the Toronto stations in order to permit the organization of the operating staff during the period of construction. A senior position, reporting directly to Management, of Director of Television, was established for each location and, under him, positions of equal responsibility, Technical Director and Program Director. These men, with their respective assistants, formed the nucleus of the operating group for each station and under the general guidance of the Coordinator were given the responsibility of developing program plans, determining staff requirements and setting up training and hiring schedules timed to fit with expected completion dates for the stations.

Presented on October 6, 1952, at the Society's Convention at Washington, D.C., by J. E. Hayes, Canadian Broadcasting Corp., P.O. Box 6000, Montreal, Canada.

Throughout all this preliminary work, special emphasis was placed on complete cooperation between program and engineering since it is our conviction that only through such cooperation is it possible to achieve the best results. This teamwork is quite necessary even during the design of the stations since the design engineers must be kept informed regarding program plans in order to be in a position to provide the most suitable equipment. On the other hand program plans must be developed with a consciousness of the cost of technical facilities which may be required by the programs envisaged.

The two stations which are now in operation in Montreal and Toronto are the result of this type of cooperative effort and we believe the result will justify the amount of planning and thought that has gone into their development. Actually, we had hoped to be in operation several months earlier, but shortages of steel for towers, delayed deliveries of electronic components and other incidents of a completely non-technical nature have hindered our progress.

Technical Facilities: The facilities supplied in the two stations are, in general, the same, although there are certain minor differences which were brought about by local conditions. Basically, each station consists of two studios, film recording and reproducing facilities, a mobile unit, a 5-kw picture transmitter, and a 3-kw sound transmitter. In Toronto this equipment and office space for technical and production personnel are housed in a five-story building located in the center of the city. The antenna, a 6-bay turnstile, is mounted at the top of a 500-ft self-supporting tower which is adjacent to the main building. The transmitter operates on channel 9 (186 to 192 mc) with an effective radiated power of 26 kw.

In Montreal, the transmitter and studios are separated. The television studios are located in a new five-story annex to the Radio-Canada Building, a twelve-story structure which houses our engineering offices and all our sound studios and operations personnel for the Montreal area. The transmitter and antenna are located on top of Mount Royal, which is situated in the center of the city. The tower height of 283 ft (a limit imposed by aviation restrictions) plus the height of the mountain results in an overall antenna height of about 936 ft above average terrain. The transmitter operates on channel 2 (54 to 60 mc) and with a 3-bay turnstile antenna provides an effective radiated power of 16 kw for the picture carrier.

Because of the delay in obtaining the towers, it was found necessary to erect 70-ft temporary masts on top of the transmitter buildings in both cities. Single-bay antennas were erected at the top of these temporary masts in order to permit operation of the stations prior to completion of the main towers.

This rather brief description gives a fairly general picture of the two television installations. A more detailed description of the Montreal station will serve to show the extent of the facilities being provided.

The five-story studio building is 67 × 90 × 46 ft high. It has a cube of 455,000 cu ft, and is of fireproof construction. This building houses two production studios, a film recording and reproducing room, and control rooms, but does not include office space for the technical and production staff of the station.

In the basement there are scenery shops, with woodworking and painting sections, storage space, a room for refrigeration equipment, and dressing rooms. The scenery shops are equipped with power tools, hand tools, and painting facilities necessary for the production of scenery. Paint-spray equipment, a heavy-duty sewing machine, and other necessary tools, are supplied for the production of flats and backdrops.

Fig. 1. Control room for the small studio. At the left of the picture is the audio console, then the positions for the program producer and his assistant followed by the technical producer and camera control operator.

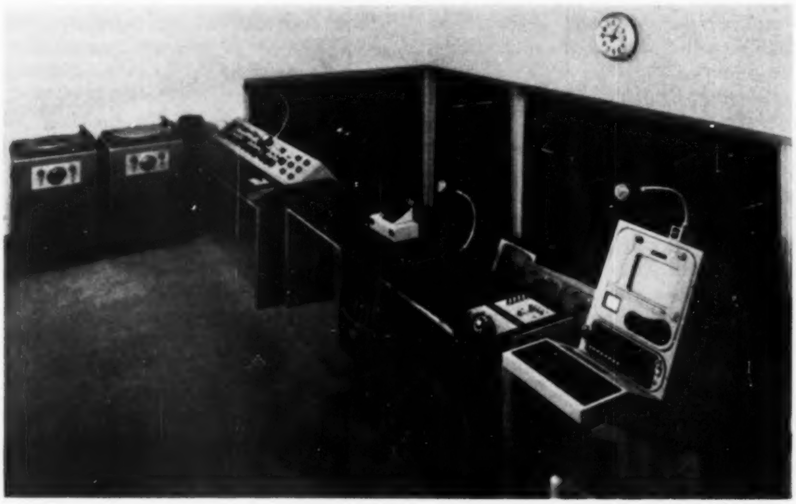


Fig. 2. Control room for the large studio. The audio control position is at the left of the picture; the producer and his assistant work at the central desk. Camera control operators are seated at a lower level. The technical producer operates the camera switching console at the right.

The first floor is occupied by the large studio. The second floor has the control room, observation room, announce booth, and the upper part of the main studio. The third floor has the smaller studio, a storage room for props, a clients' room, an announce booth, and control room. The fourth floor is occupied by the upper part of the small studio, master control room, the film recording and reproducing room, a maintenance shop, film editing room, and additional storage space. Ventilating equipment is located on the fifth floor, which is approximately one half the area of the other floors.

Large Studio: The large studio is 90 × 60 × 25 ft high and occupies two stories. It is equipped with three cameras, one of which is mounted on a small camera crane, and the other two are mounted on pedestal dollies. One large and two small microphone booms are provided, as well as video and audio monitors, and a complete production intercommunication system. The cameras and all the video equipment for both Montreal and Toronto studios were manufactured in England, but are similar in general design and operate on the same standards as equipment available in the United States. The lighting equipment, totalling about 70 units, includes an assortment of scoops, 6-in. and 8-in. spotlights, and a few striplights and fluorescent units. Lighting control panels permit individual switching of 80 circuits, and dimmers allow independent adjustment of 10 different banks of circuits. Pantographs are provided to allow adjustment in a vertical direction of 16 of the lighting units. The control panels and wiring are arranged to permit expansion, since it is expected that the lighting facilities may eventually be approximately double the initial installation.

Small Studio: The small studio, which is 65 × 44 × 19 ft high, occupies part of two stories. It is equipped with units similar to those already described, except that there are only two cameras, one of which is mounted on a small camera crane, and the other on a pedestal dolly. The number of lighting units is approximately one half of those in the larger studio.

No provision has been made in either of these studios for the accommodation of a studio audience, since it is much more economical to use all available space for studio production. Audience participation shows requiring a small audience can, of course, be handled by bringing a limited number of people into the studio for that particular program.

Control Rooms: Each studio has its own control room arranged to overlook as much as possible of the associated studio. The master control room is located on the fourth floor, and has observation windows at one end, to permit visitors to see the equipment without interfering with operations. The control rooms are shown in Figs. 1 and 2, and the master control console in Fig. 3.

Film Recording and Reproducing Facilities: The film recording and reproducing room is located on the fourth floor adjacent to master control. The film reproducing equipment (Fig. 4) is of a new design using an image orthicon camera similar to those in the studios. It includes two 16mm projectors and two slide projectors, all of which can be remotely controlled.

Film recording equipment is provided to permit the recording of television programs on 16mm film. This equipment provides a direct-positive picture from a negative image on the tube. With this equipment only a single print is available, and facilities for producing additional prints will be added later as the need arises.

A magnetic tape recorder is located

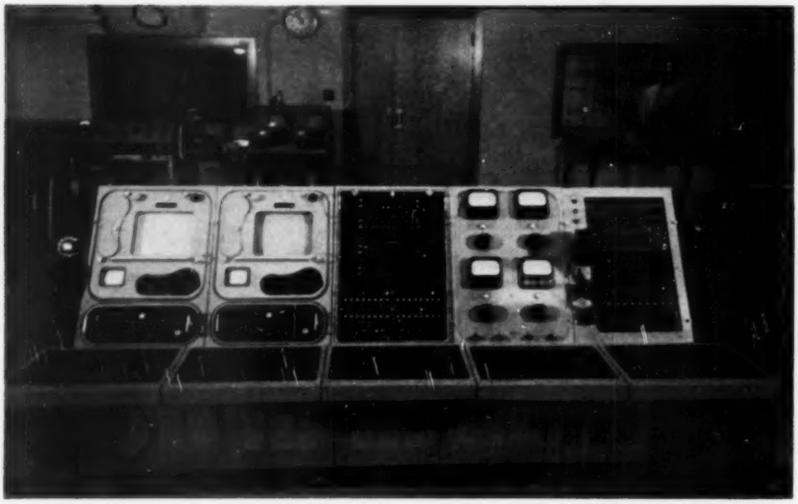


Fig. 3. Master control console. This console has two monitors for incoming programs, and switching, audio and order wire panels. The console accepts audio and video signals from the studios, film reproducing equipment, network or mobile unit microwave. These signals may then be routed to the transmitter, film recording equipment or network as required.

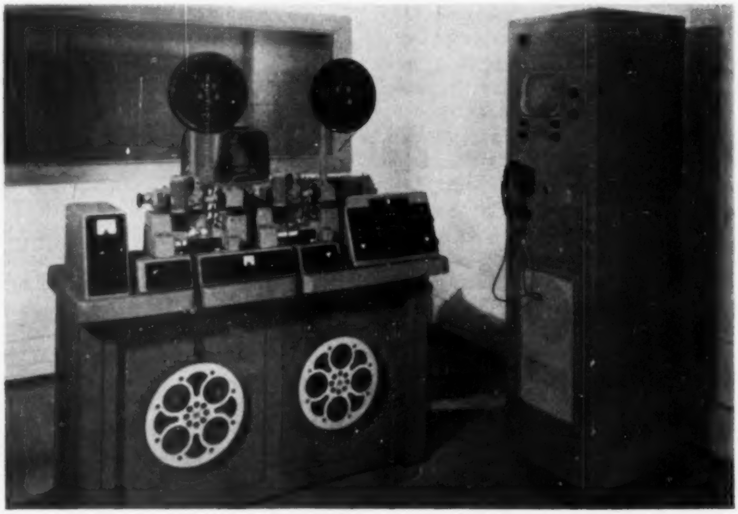


Fig. 4. Film reproducing equipment and monitor rack. This equipment combines two 16mm projectors and two slide projectors and feeds the optical output from the projectors into an image orthicon camera visible at the rear of the unit.

in the film recording and reproducing room, to be used, as required, for the recording and playback of commentaries for newsreels. It may also be used for recording the sound portion of film recordings as a protection against possible loss of the optically recorded sound track during recording or processing.

Photographic Equipment: A Houston processor for developing 16mm film is installed in the Toronto station to permit processing of our film recordings, newsreels, and other 16mm films. A second processor will be installed in Montreal if the load becomes sufficiently heavy to justify the additional unit. There is also an assortment of auxiliary photographic equipment to facilitate satisfactory editing, titling and cleaning of films. 16mm motion picture cameras are available for taking newsreels, drama fills, and other similar pictures. Still cameras, an enlarger and developing equipment are provided for the purpose of making slides and for various other uses around the studios.

Mobile Unit: A mobile unit equipped with three camera chains, a microwave relay transmitter, and all necessary auxiliary equipment is used for televising sports, special events and other subjects outside the studios.

Normally, the microwave transmitter for the mobile unit relays the signal back to a receiving point on top of the Radio-Canada Building, but in the event that a line-of-sight path does not exist between the remote location and this receiving point, a second receiving point is available on the transmitting tower.

Transmitter Building: The Montreal transmitter building (Fig. 5) is located on the top of Mount Royal on a site which has been leased to us by the City. The building is large enough to house two 5-kw transmitters with the associated 3-kw sound transmitters and in addition, the two 3-kw frequency modulated VHF transmitters which are at present operating from the Keefer Building in Montreal. Some extra space has been set aside to permit future power increases of the television transmitters.

The antenna tower is located adjacent to the transmitter building. At a height of 120 ft above the base there is a platform to support the microwave receiving equipment to be used, when required, with the mobile unit. Above this is a straight section of tower designed to take a 6-bay "super-gain" type antenna to be used in conjunction with a future second television transmitter on channel 6. Then follow two "pylon" type antennas for the two frequency-modulated transmitters and finally, at the top, the 3-bay turnstile antenna for the present television transmitter.

Television Network: The CBC has entered into a contract with the Bell Telephone Company of Canada for a television network connecting Toronto and Montreal via Ottawa and, as well, for a link with the United States television networks via Buffalo, N.Y. A chain of microwave relay stations is under construction along the 374-mile route and, although it is not expected that the complete network will be ready for use before May 1953, the section between Buffalo and Toronto is now in operation. It appears probable that this network could be extended eastward as far as Quebec City and westward as for as Windsor, Ontario, before very long, but a coast-to-coast network across Canada seems to be in the somewhat more distant future. Plans are now underway for the construction of television stations in Vancouver, Winnipeg, Ottawa and Halifax. The Ottawa station will normally be fed via the network from the Montreal and Toronto production centers, but will have facilities for originating programs of special interest from the Capital City. The stations in Vancouver, Winnipeg and

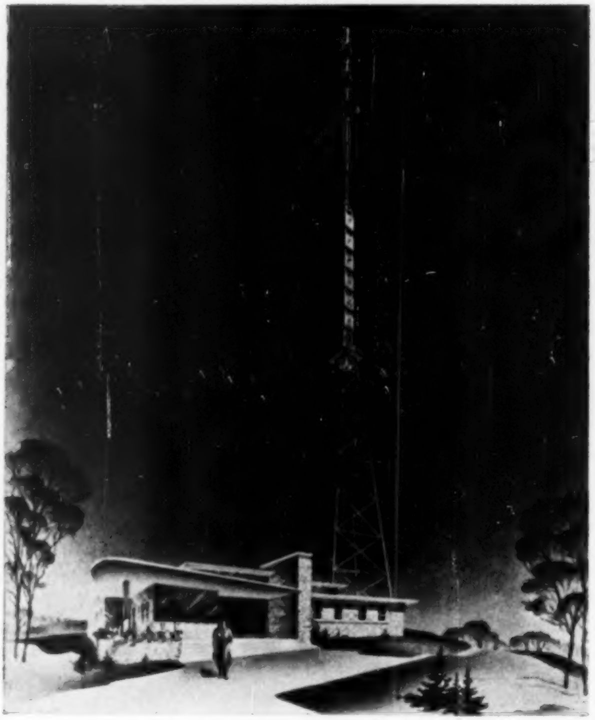


Fig. 5. Transmitter building and antenna structure. The transmitter is located on top of Mount Royal. The turnstile antenna at the top is for the present television transmitter on channel 2. The tubular section consists of two pylon antennas for frequency modulation transmitters. The illustration also shows an antenna for a future transmitter on channel 6. The balcony will support a microwave receiving antenna for use in conjunction with the mobile unit at times when the latter is not within line-of-sight of the studio building.

Halifax will depend on kinescope recordings of Montreal and Toronto productions for most of their schedule, but they will have sufficient facilities for a limited amount of local production.

Program Plans: The recent report of the Royal Commission on National Development in the Arts, Letters and Sciences, more popularly known as the Massey Report, made certain recommendations with regard to the objectives which should determine the choice of material for Canadian radio and television programs. Guided by these recommendations, the CBC intends to make full use of this new and tremendously effective means of expression in the development of Canadian talent and ideas. We believe that it should be used not only as a means of entertainment, but also as a medium for the awakening of a greater appreciation and a better understanding of the more important fields of human endeavour.

The incorporation of this ideal into

a balanced and diversified program schedule requires that the CBC should keep control over the type and quality of all programs it carries. Consequently, commercially sponsored programs will be accepted only when the CBC considers them to be of sufficiently high quality and of suitable content.

Programs are being produced in two languages — English in Toronto and French and some English in Montreal. In addition, the film-recording equipment permits an exchange of programs between the two cities prior to the completion of the microwave network. Experience in sound broadcasting has proven that a bilingual program service is not entirely satisfactory to the majority of listeners, and it is expected that before long a second transmitter will be installed in Montreal to permit independent programs for the French and English viewers. The completion of the network between Toronto and Montreal will make the addition of the second transmitter a logical step. This will not be too difficult to do from a technical standpoint since the layout of the existing equipment has been made in such a manner that the second transmitter with its associated facilities may be added and integrated with the existing equipment.

The two stations began a limited television service during August and the official inauguration of the service took place early in September. The initial program schedule is being limited to approximately three hours in the evening with the expectation that the number of hours will be increased gradually as the service develops.

Discussion

Louie L. Lewis (*WOI-TV, Ames, Iowa*): Are you going to distribute your programs by relay only, or are you going to distribute them by kinescope also?

Mr. Hayes: We will have to use kinescope recordings to feed Winnipeg, Vancouver and the Maritimes Station. We foresee the microwave network extending east of Montreal to Quebec City and west of Toronto as far as Windsor, but it may not be economical to extend it farther. At present we are exchanging programs between Montreal and Toronto because the network is not yet operating between these cities.

Mr. Lewis: Are you going to make positives and negatives then, and make copies?

Mr. Hayes: We expect to do so as soon as additional stations are in operation. For the moment we are not making any prints but are sending the one and only copy from one station to the other.

Barton Kreuzer (*RCA, Camden, N.J.*): How many stations of the Canadian Broadcasting Corporation are operating now, TV stations?

Mr. Hayes: Two. Just the one in Montreal and the one in Toronto, and we have four more under construction.

Mr. Kreuzer: Where are those four?

Mr. Hayes: Winnipeg, Vancouver, Ottawa and one in the Maritimes. Actually the physical construction hasn't started, but we are locating sites and carrying out the engineering on these stations.

Use of Ansco Color Film in Commercial Production

By REID H. RAY

The selection of a 35mm color film for the documentary or commercial motion picture producer is a problem of choosing an economical and, from a processing standpoint, a practical type of color film. Both color and black-and-white (35mm and/or 16mm) are sometimes required and a color film which adequately fills such requirements is described here.

Documentary and commercial motion picture producers frequently must supply to their sponsors 35mm and 16mm *color* prints, and for television either 35mm or 16mm *black-and-white* prints. A color film which might be used for multiple purposes would be an economical as well as a practical medium. Production time would be saved, as one crew, with a single camera setup, could produce a master 35mm color negative.

An acceptable 35mm negative-positive type of color film, which meets the requirements of such multiple duty, has been in use at our studio since April 1951. From the one original color negative, four types of release prints have been made (Fig. 1):

1. 35mm color prints,
2. 16mm color prints,
3. 35mm black-and-white prints, and
4. 16mm black-and-white prints.

Presented on October 18, 1951, at the Society's Convention at Hollywood, Calif., by Reid H. Ray, Reid H. Ray Film Industries, Inc., 2269 Ford Parkway, St. Paul 1, Minn.

The material used is "Ansco 35mm Color Camera Film, Type 843, Daylight Balance." This film supersedes Ansco Type 735, a reversible color material which was discussed by the author in a previous paper published in the *Journal*.[1] The characteristics of this color negative have been described in the *Journal*.[2] This paper will describe the use of this color film in the commercial field. (A demonstration reel was shown at the conclusion of the paper.)

The speed of Type 843 Ansco Color Negative is rated at ASA 10 and an ultraviolet 16 filter is recommended for both interior and exterior photography. Arc illumination is used for interiors with Y-1 correction filters on high-intensity arcs. Both incident and reflected light readings are taken in various locations on the set to check evenness of illumination. To achieve a warmer tone in a background, 5-kw or 2-kw solar spots may be added to supplement the key- and backlighting from arcs.

For exterior photography with this type of color film, as in all color work, bright, clear sunlight is a prime requisite, and generally the rule of "the sun

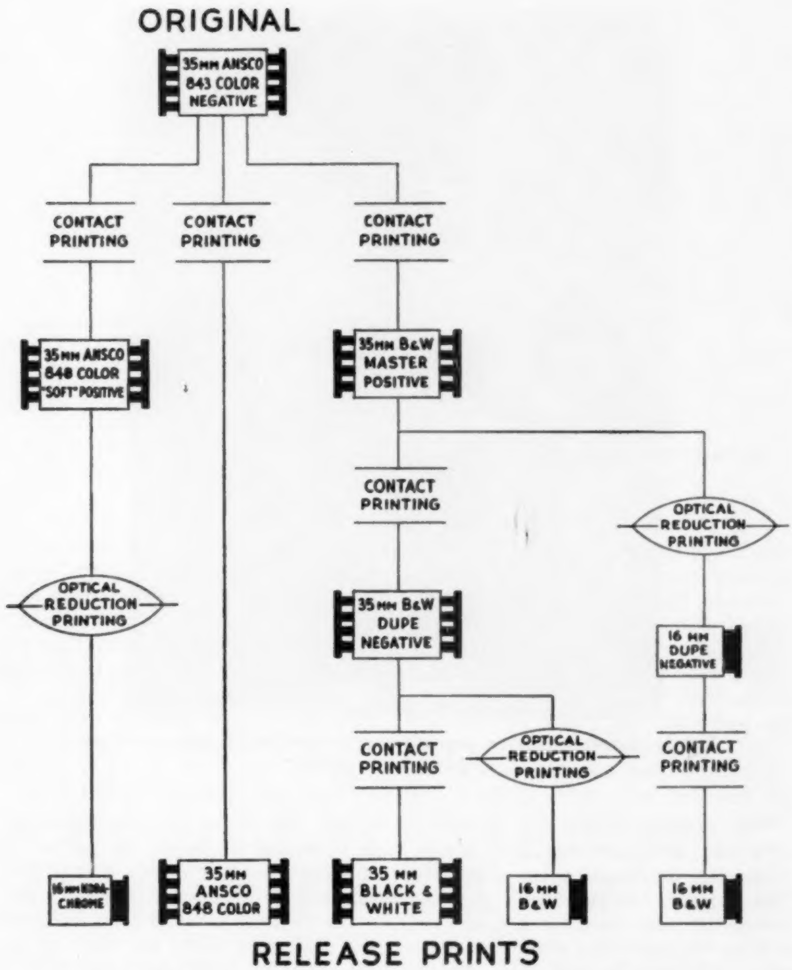


Fig. 1. Methods of release printing from Ansco 843 Color Negative.

behind the camera" holds. However, very pleasing and excellent results have been achieved with sidelighting. Close-ups of characters completely backlighted by the sun, and frontlighted by booster lights or aluminum-foil reflectors show good latitude in the flesh tones.

Makeup used for interior photography for men is Max Factor No. 27 Pancake sparingly applied. For women, ordinary street makeup is recommended.

The exposed negative material which our studio produces is sent to the Houston Color Film Laboratories for developing and printing. A brief summary of these processes are[3]:

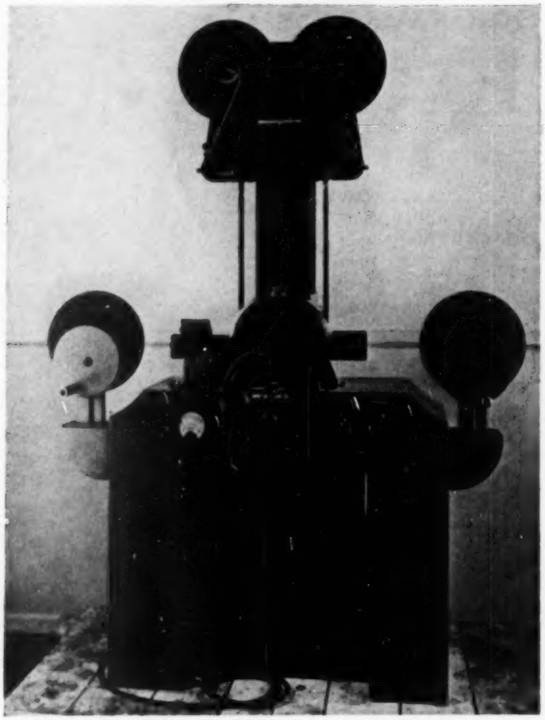


Fig. 2. Houston-Fearless Scene Tester — used for making scene test strips for color prints.

The negative material is developed in a color developer containing a non-toxic color developing agent called S-5. The negative is developed approximately 10 min, based on a gamma of 0.85 for the cyan layer of the monopack film. The film is then short-stopped, hardened, washed, bleached, washed, hypoed, washed and dried.

A scene test for prints from Ansco 843 Negative is similar to a cinex, the main difference being that each frame on the strip is made from a different filter balance, but each frame receives the same printing light intensity. This necessitates three tests being made on each scene, generally three printer points apart, in order to give a density range. The scene tests are developed in a positive developer similar to the negative developer, except that it does not have an accellerator in the solution.

The negative is timed from the scene tests. Separate filters are made up for scene-to-scene color correction and a modified Bell & Howell printer with an automatic filter changer handles the filter combinations (Fig. 3). This filter change is made in conjunction with the notch used for the printer light changes.

The positive stock used is Ansco Type 848 and is developed to a gamma of 2.30 on the red record, being the cyan layer.

The sound is printed from a black-and-white negative track. In order to

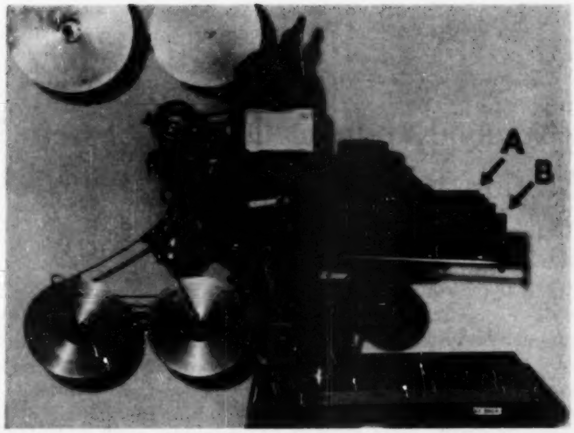


Fig. 3. Modified Bell & Howell Model D Printer with filter bins. A: feeding bin; B: receiving bin. Filter passes from feeding bin to position in front of light, to receiving bin.

obtain normal transmission through the optical system, since the positive stock is a monopack film, it is necessary to redevelop the track area with an application of a viscous solution containing a high-energy developer. With the track area so treated there is no difference in sound level between this type of color print and a normal black-and-white print.

When 16mm color prints are required they are made from a 35mm "soft" color print by optical reduction to a 16mm color duplicating stock. The sound is optically reduced from a 35mm re-recorded direct positive track.

A satisfactory 35mm black-and-white negative can be produced by using the original color negative to print a fine-grain master print on Eastman 5365 stock and by developing this to a gamma of 1.2. From this, a duplicate negative is made on Eastman 5203 or similar duplicating negative material. This duplicate negative is developed to a gamma of 0.66.

The commercial producer works without benefit of large budgets and he must turn out color motion pictures under conditions not always conducive to extensive production conveniences. The producer who wishes to operate with a minimum crew and regular black-and-white camera equipment, may use a multipurpose color film described in this paper to good advantage.

(The demonstration reel consisted of: first, a 35mm color print, followed by portions of the same footage in 35mm black-and-white print from the dupe negative.)

References

1. Reid H. Ray, "Use of 35mm Ansco Color Film for 16mm color release prints," *Jour. SMPE, 53:* 143–148, Aug. 1949.
2. Herman H. Duerr, "The Ansco Color Negative-Positive Process for motion pictures," *Jour. SMPTE, 58:* 465–479, June 1952.
3. Data furnished in 1951 by Robert F. Burns, Laboratory Manager, The Houston Color Film Laboratories, Inc, Burbank, Calif.

A Fast-Acting Exposure Control System for Color Motion Picture Printing

By JOHN G. STREIFFERT

An illuminating system in a contact-printer for color motion pictures is described. Light from a single lamp is divided into three beams which are independently filtered, controlled in intensity, and projected onto the printer aperture. Intensities of the red, green and blue components of the exposing light are measured continuously and photoelectrically and compared with reference voltages which are the analogs of the desired intensities and which are controlled by a perforated tape according to the predetermined requirements of each scene to be printed. Any errors between measured intensities and desired intensities, i.e., between photocell outputs and reference voltages, are amplified and applied to servomotors which rotate vanes in the respective beams until the correct intensities are established. A response time of the order of 1/50 sec has been achieved, and the intensity of the printing light is substantially independent of lamp current and age. A manual control on each of the reference voltages provides for emulsion-to-emulsion variations in print stock.

An illuminating system in a continuous contact printer used for making motion picture color prints must fulfill many requirements. The more difficult requirements to attain are:

1. Sufficient illumination to expose the color positive material at a printing speed of at least 100 fpm.

2. Provision for control of exposure and/or color balance to compensate for scene-to-scene variations in negative density and color balance and for emulsion-to-emulsion variations of the positive material. The change in exposure or color balance should be made in a sufficiently short time so as not to be perceptible in the projected picture. Ideally, this change should occur within the frame line. In practice, an operating time of one frame is considered satisfactory, provided there is no overshoot in the system which would cause one frame to be noticeably lighter than adjacent frames.

In addition to these two requirements, it is desirable that the exposure and color balance be substantially independent of the operating voltage and the age of the lamp; that the power consumption of the light source be moderate; and that the optical, electrical and mechanical elements of the system be simple and reliable.

An optical and exposure control

Communication No. 1517 from Kodak Research Laboratories, a paper presented on October 8, 1952, at the Society's Convention at Washington, D.C., by John G. Streiffert, Eastman Kodak Co., Kodak Park Works, Rochester 4, N.Y.

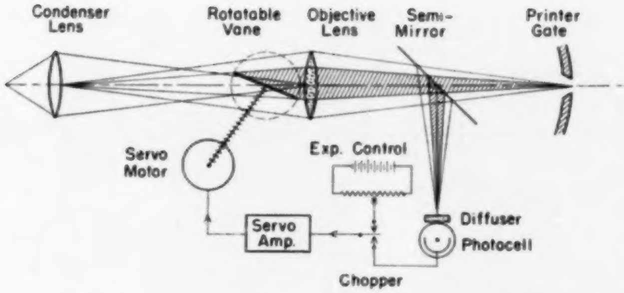


Fig. 1. Schematic drawing of a projection-type optical system with servocontrol of intensity at printer gate.

system designed to meet these requirements is described below.

A simple projection-type optical system with a high-aperture condenser lens and a high-wattage lamp is illustrated schematically in Fig. 1. The condenser lens forms an image of the lamp filament in the objective lens, and the objective lens, in turn, forms an image of the uniformly illuminated condenser lens in the printer aperture. One method of controlling the intensity of illumination at the printer aperture without affecting uniformity is to change the aperture of the objective lens by means of an iris diaphragm or other mechanical masking means, such as the rotatable vane placed near the lens (Fig. 1).

In general, however, the intensity will not change linearly with changes in position of the iris or the vane, because of the nonuniform structure of the filament image. The necessity for a calibrated relation between intensity and vane position can be obviated by means of a servosystem in which the intensity is measured photoelectrically and adjusted automatically and continuously to the correct value (Fig. 1). This is done by comparing the voltage developed by the photocell with a reference voltage, shown schematically as the output of the potentiometer. Any difference between these voltages is amplified and fed into the servomotor which rotates the vane in a direction to reduce the error. The reference voltage set up by the potentiometer is thus the analog of the desired exposure, and scene-to-scene changes in exposure can be made simply by readjusting this reference voltage.

An additive system of color exposure requires three simultaneous exposures, red, green and blue, whose intensities are controlled individually and preferably independently. In Fig. 2 is shown an optical system in which three beams are derived from adjacent segments of a common condenser lens. Mirrors reflect light from the upper and lower segments of the condenser lens into prisms which direct these beams onto the printer aperture at angles of 15° to the central beam. The sizes of the prisms are chosen to compensate for the difference in path length between the outer and central beams; in this way, identical objective lenses can be used in the three beams. Red, green and blue filters at the objective lenses substantially restrict the exposure of each beam to one of the three color primaries. A beam-splitting mirror reflects a small fraction of the filtered light onto an opal glass which acts as an integrator. Beneath the opal glass are three photocells with red, green and blue filters over them. The output voltages of the three photocells are

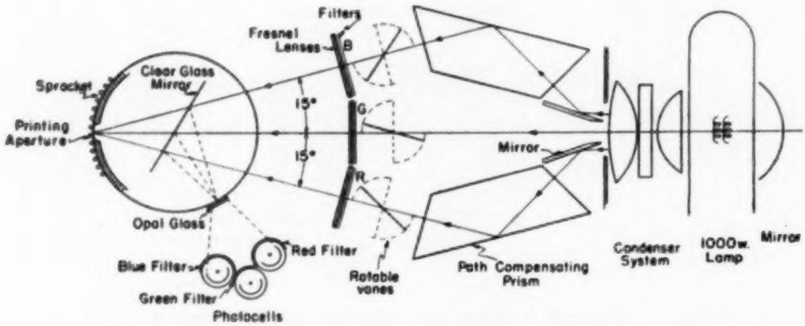


Fig. 2. Schematic drawing of projection-type optical system for controlled additive trichromatic illumination using a single lamp.

compared with three reference voltages, which are the analogs of the desired red, green and blue exposures. Any difference between photocell and reference voltage is amplified by one of three amplifiers and applied to the appropriate servomotor to reduce that difference to zero.

Figure 3 shows a Bell & Howell Model D Printer which has been modified to incorporate the optical system shown in Fig. 2. The outer half of the sprocket was removed to eliminate interference of the sprocket hub with the central light beam. The original light-control shutter mechanism was discarded. In its place a steel block was provided which carries bearings for a film-driven flange which supports the outer edge of the film in place of the original outer half of the sprocket.

The original cylindrical lamphouse has been replaced with a square box which houses the lamp and the optical system. The cylindrical housing on the front of this box houses one of the servomotors. The other two motors are on the rear side of the box. At the extreme right is the electronic complement consisting of the power supply below, above that the amplifier box, and on top a tape-controlled contactor. This contactor reads timing information which is stored in the form of an array of holes punched in a strip of 16mm film.

Figure 4 is an interior view of the lamphouse showing the optical system. Two of the rotatable vanes can be seen to the left of the prisms. The third is seen in the foreground protruding from the hinged cover. The outer film-supporting flange has been removed to show the plate which holds the beam-splitting mirror on its back side. The photocell enclosure has also been removed to show the three photocells beneath the sprocket enclosure.

The 16mm control tape is advanced, one frame at each scene change, by means of a solenoid to establish a new set of reference voltages. In the amplifier circuit of Fig. 5, the tape-controlled contactor controls a battery of fifteen relays, five for each color, which, in turn, control attenuators in the reference voltage circuits. These attenuators are calculated to provide attenuations of 0.4, 0.8, 1.6, 3.2 and 6.4 db, which are equivalent to exposure changes of 0.02, 0.04, 0.08, 0.16 and 0.32 log E. If several relays are energized, these attenuations add, so that a total exposure range of 0.62 log E in steps of 0.02 log E is provided for each color. The three knobs shown on the front of the amplifier box, Fig. 3, are

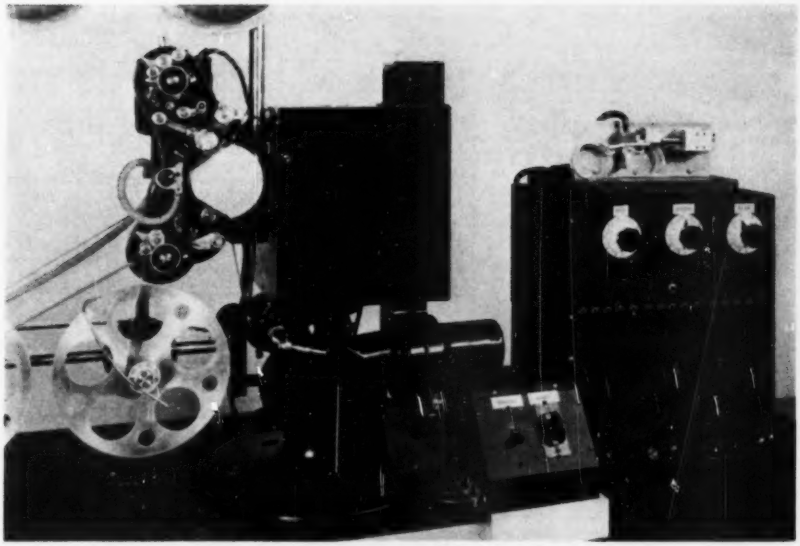


Fig. 3. Printer with new lamphouse. Control tape reader, servoamplifiers, and power supply are at right.

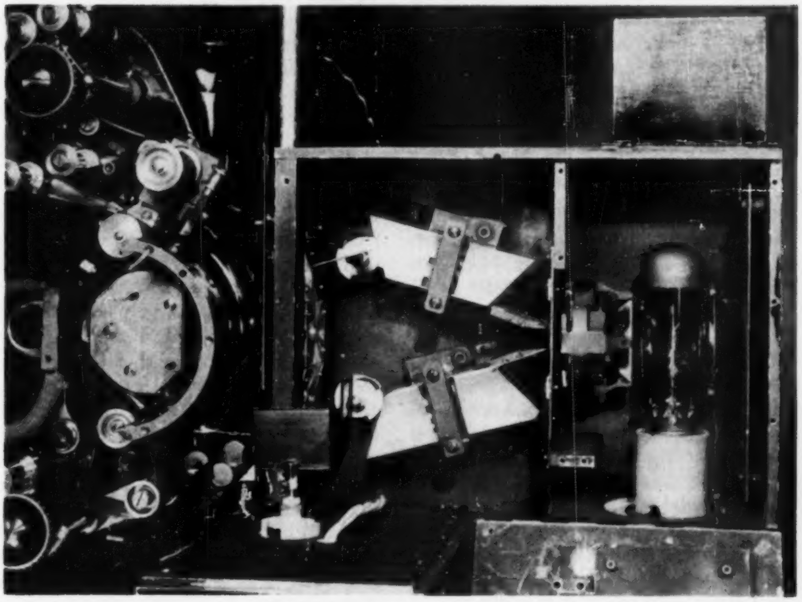


Fig. 4. Interior of lamphouse and optical system.

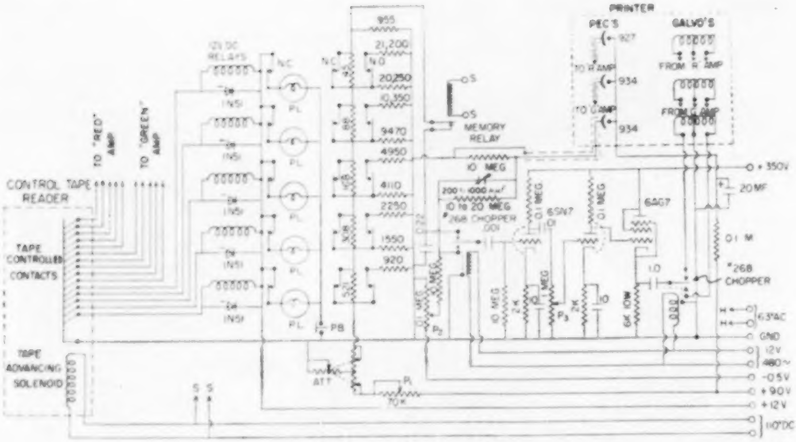


Fig. 5. Schematic circuit of servoamplifiers.

manually controlled attenuators used for setting the operating range of the automatic system and for any compensation for emulsion-to-emulsion differences in the print stock.

The comparison between photocell output and reference voltage is made by means of an electromagnetic chopper. This chopper switches the input to a three-stage amplifier from the photocell output to the reference voltage 480 times per sec. Thus, any unbalance between the photocell output voltage and reference voltage is transformed into a 480-cycle signal. The amplifier output is synchronously rectified by a second chopper.

The servomotors are heavy-duty d'Arsonval galvanometer movements originally designed for graphic recording purposes. The coils are mounted on ball bearings and all restoring torque is removed. The pivot shaft on one end of the coil was extended and the vane mounted directly on this shaft.

Potentiometer P_2 is used for balancing out any voltage generated by the photocell dark current. Potentiometer P_3 adjusts the gain of the amplifier, i.e., the stiffness of the servoloop. It is adjusted for good response without overshoot. An Antihunt network is included between the photocell load resistor and the chopper. This materially improves the transient response of the servosystem. Constants are adjusted for best performance of each amplifier.

The coil of the memory relay is connected in parallel with the solenoid which advances the exposure control tape. Thus, the 0.22-μf condenser connected to the relay contact holds its charge and prevents the servosystem from attempting to follow the operation of the attenuator relays while the control tape is being advanced. After the tape has come to rest in its new position, the memory relay closes and the condenser assumes the new voltage established by the relay-controlled attentuator.

In Fig. 6 is shown the circuit diagram of the power supply. The high-voltage supply is of the choke-input type so that a 480-cycle signal can be picked off the high-voltage rectifier by means of a circuit tuned to the fourth harmonic of the ripple frequency. This signal is amplified and used to drive the six choppers. Potentiometers across the 6.3-v heater circuits and across the 12-v, 480-

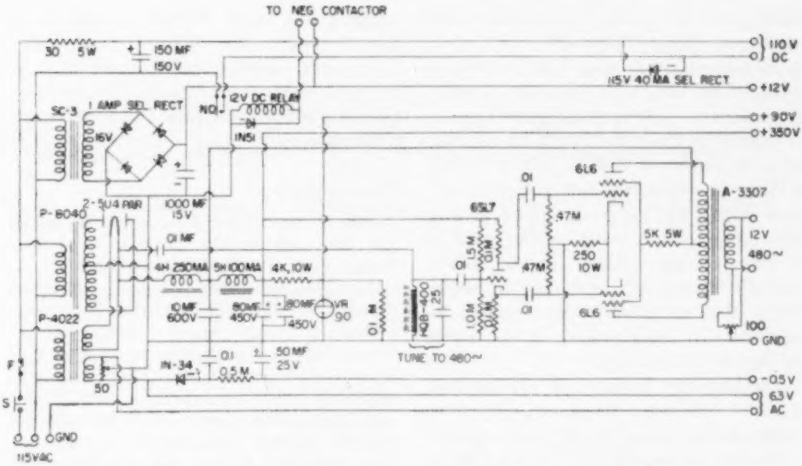


Fig. 6. Schematic circuit of power supply for servoamplifiers.

cycle output are adjusted for minimum residual signal at the output of the amplifiers when the photocells are dark and the outputs of the reference voltage potentiometers are grounded. The germanium and selenium diodes across the relay coils are for contact spark suppression.

The filters associated with the photocells have been chosen so that the spectral sensitivity of the photocell as modified by the filter matches approximately the spectral sensitivity of the respective component of the color print emulsion. For measuring the red exposure, an S1 photosurface and a Kodak Wratten Filter No. 29 are used; for the green, an S4 photosurface and Kodak Wratten Filters Nos. 57A and 16 are used; and for the blue, an S4 photosurface and Kodak Wratten Filters Nos. 47 and 2B are used.

The same relatively sharp-cutting filter combinations are used to filter the three beams in the optical system in order to provide a wide range of control of color balance. If less selective filters were used, a given filter might permit enough leakage of light in an adjacent band so that the exposure in that band could not, in extreme cases, be reduced to a sufficiently low value. This would only occur when printing badly unbalanced negatives. If experience proves that negatives are relatively uniform in color balance, less selective filters can be substituted in the optical system, with a resulting increase in the available overall exposure.

Performance

The normal operating speed of this printer is 100 fpm. The lamp used is a 1000-w, 120-v, T-12 prefocus lamp, operating at 100 v. Under these conditions there is a 0.6 log E margin in exposure above that required from printing a normal negative onto Eastman Color Print Safety Film, Type 5381. As first stated, the tape-controlled exposure adjustment covers 0.62 log E in 0.02 log E steps, or a total of 32 steps. If the system is adjusted so that a normal negative prints at Step 16, then there is a range of ± 0.30 log E available for over- and underexposed negatives.

The lamphouse is cooled with a 200-cfm blower and the air path through the lamphouse and light baffles is designed for a minimum of resistance so that the

cooling of the lamp, lamphouse, and condenser system is very effective. Also, as mentioned, the lamp can be undervoltaged by 17% with adequate margin of exposure. Under these conditions it is estimated that the lamp life should be of the order of 200 hr. In a system of this type with servocontrol of exposure, there need be no concern regarding blackening of the lamp or fluctuations in line voltage. These factors affect only the maximum available exposure. Below this maximum, the exposure is substantially independent of the lamp voltage or its condition.

The response time of the servosystem is about 0.02 sec. Thus, at a printing speed of 100 fpm, the exposure change is effected in one-half the frame height.

Because of the large vertical angle between the three light beams, color fringing will occur if there is poor contact between the films. Thus, the divergence between the colored beams is, in a sense, an advantage in that it gives a positive indication of poor printer performance.

Discussion

Paul Ireland (EDL Company): Is there any provision for the calibration of this to take care of drift in the photocell?

Mr. Streiffert: Not inherently in this system. I have a photoelectric exposure-measuring device which consists of a bracket which I can screw in front of the printing aperture and in which I can insert photocells with appropriate filters — the same filters which are used in the optical system. That's connected to a vacuum tube voltmeter and is used for checking exposure from time to time to be sure that it's constant.

Motion Picture Studio Lighting and Process Photography Report

By JOHN W. BOYLE, Committee Chairman

THE BASIC COLOR sensitivity of the Technicolor process has been changed to a color temperature of 3350 K. When white light sources, such as sunlight, are used, the camera optical systems are filtered for proper balance. Incandescent tungsten filament lamps of the proper color temperatures are used unfiltered. When carbon arcs are used mixed with unfiltered tungsten lamps it becomes necessary to filter the carbon arcs to the lower color temperature. This is accomplished by using one MT-2 and one Y-1 filter on all high-intensity arc spotlamps and one MT-2 filter only on Duarc flood lamps. It is possible, however, to filter the camera optical train for sunlight balance and use the carbon-arc floodlamps unfiltered, the high-intensity carbon-arc spotlamps with only a Y-1 light yellow straw filter, and to filter the incandescent lamps with whiterlite filters as in the past. This gives the system a greater latitude so it may be used with incandescent tungsten lamps alone, where desired, at a key-light level as low as 150 ft-c; or with carbon arcs, or sunlight, with a key-light level of 300 ft-c; or with mixed lighting in either case provided the light sources are all adjusted to the balance of the particular camera filter system.

With these changes a number of things are being tried in efforts to simplify, reduce costs and to improve the existing lighting equipment situation.

Many sets are being illuminated almost entirely, or entirely, with incandescent lamps. The 10-kw bulb has again been brought into use (Fig. 1), also the Type T-5 5-kw lamp, which was not previously in favor because of restrictions as to beam spread and overall dimensions, as compared to the Fresnel type 5-kw units.[1]

On large sets the 225-amp carbon-arc "Brute" lamp, filtered to 3350 K, has been used a great deal for long throws and effect lighting.[2]

While the situation caused a drastic change in lighting methods and equipment, some studios are now exploring the values of the new system on both a 3350 K and a white-light basis. In other words, where they have a large set with follow-spots, or where night exteriors are to be photographed, they merely change the filter arrangement in the cameras and shoot on a white-light basis.

Both Eastman and Ansco color negative films are balanced to white light and therefore, with these systems carbon arcs are used for "booster" lights outside as well as for interiors. When in-

A report submitted on September 4, 1952 by the Committee's Chairman, John W. Boyle, Director of Photography, 139½ S. Doheny Dr., Los Angeles 48, Calif.

Fig. 1. MR Type 416 "TENER" 10-kw incandescent lamp.

Fig. 2. Paramount Pictures' system of remote-controlled incandescent studio lamps.

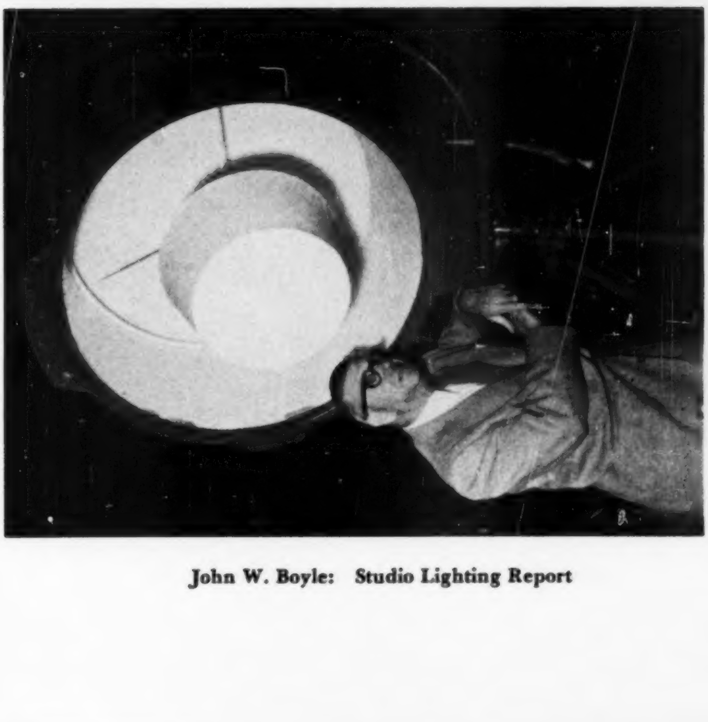


Fig. 3. Reflected light unit designed by Metro-Goldwyn-Mayer Studios.

Fig. 4. Reflected light unit designed by Columbia Studios.

Fig. 5. Set used in Desilu Productions "I Love Lucy."

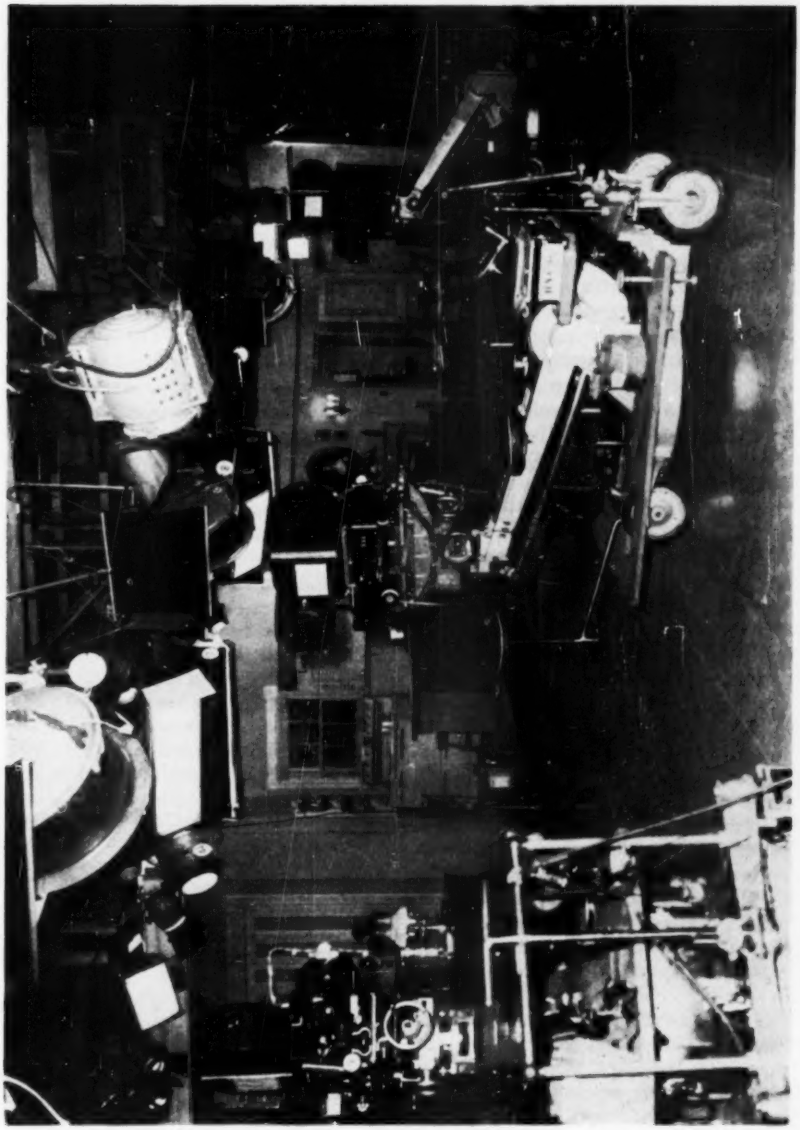


Fig. 6. Set used in Desilu Productions "I Love Lucy."

candescent lamps are used they are equipped with whiterlite filters.

The Paramount Studio's engineering department has developed a remote-control lighting system for use with incandescent lamps (Fig. 2).[3] With this system lightweight units, mounted in various places, may be moved at almost any angle, or the focus changed by remote control from a master station. The system was designed for use on a circus picture where the lamps had to be mounted on the tent poles; however, it is being adjusted with the thought of bringing studio lighting to an automatically controlled operation insofar as is possible. At the time of this writing only the one studio has built any of these motor-drive remote-controlled units.

Several studios have rediscovered the desirable qualities of diffuse lighting of the "north sky light" type for certain applications.[4] It is indicated for general fill-light, for supplementing more directional light on close shots, and overhead on foliage where its diffuse distribution creates a uniformity of illumination as contrasted to the heavier shadow effects produced by the Fresnel-lens type units. For the same reason it is not suitable for shadow effects.

While most of the studios have produced one or more of these "reflected-light" units, Figs. 3 and 4 illustrate types produced at the M-G-M and Columbia studios. These units are lightweight, are easily handled and rigged, are of a simple cone-and-drum shape with interior surfaces coated with flame retardent white paint which has not discolored under temperatures encountered in use.

They are fitted with either one or two bulbs from 750-w to 5-kw in size. At present the housing diameters range from 24 to 60 in., but experimental models of other sizes and shapes are being made.

Figures 5 and 6 illustrate sets used on the Desilu Productions of "I Love Lucy" which is photographed for television. This work is of particular interest because Karl Freund, the veteran Director of Photography who is in charge of photography of this show, has utilized his wide knowledge of motion picture studio lighting practice to produce "plane-lighting" and modelling effects. Many people have indicated that the use of multiple cameras and restricted economies would necessitate very flat lighting but Freund has shown that the judicious use of directional light is not only possible, but is highly desirable.[5]

In spite of the trend toward economy and simplicity of production a number of epic pictures have been made in which production values have been stressed with spectacular sets and lighting techniques. The year 1952 will probably be one where the more or less mechanical, production-line type of lighting will compete with the daring effect lighting to determine if the latter has the draw at the boxoffice which many feel to be the case. One element feels that the audiences do not know the difference between the two and because they do not know the difference, they will not feel the difference; the other element believes that spectacular lighting makes spectacular pictures.

References

1. R. G. Linderman, C. W. Handley and A. Rodgers, "Illumination in motion picture production," *Jour. SMPE, 40:* 333–367, June 1943.
2. W. W. Lozier and F. T. Bowditch, "Carbon arcs for motion picture studio lighting," *Jour. SMPTE, 57:* 551–558, Dec. 1951.
3. Arthur Rowan, "Set lighting by remote control," *Am. Cinemat., 32:* 444, Nov. 1951.
4. Leigh Allen, "Reflected light for color photography," *Am. Cinemat., 32:* 446, Nov. 1951.
5. Karl Freund, "Shooting live television shows on film," *SMPTE 72d Convention Program*, Oct. 7, 1952.

Film Dimensions Committee Report

By E. K. CARVER, Committee Chairman

The report that follows is much longer than that which the Film Dimensions Committee ordinarily has given. One reason is that it leads up to a discussion of progress toward international standards, as information on this matter has not been widespread through the Society's ordinary channels of communication. Another reason for a lengthy report is that we wish to discuss a situation concerning 16mm film, a field wherein so many people are engaged that they seldom get together in the manner that happens with those who use 35mm film. Accordingly, the committee has sent out several circular letters and desires to make a relatively long public report in an effort to reach everyone that may be interested.

A questionnaire was sent out in March, 1952, to some thirty manufacturers of 16mm film equipment, and the results have been studied. It appears from the replies to the questionnaire that we have not sufficiently emphasized the fact that the proposed change in standard dimensions will not make the present film narrower in width than the film formerly used in cameras or other equipment.

You will remember that the standards are written to describe the film "immediately after cutting and perforating." Although it was very clear in the minds of those who wrote the early standards that these standards referred to widths at the time of slitting, nevertheless there has been the tendency among equipment manufacturers to interpret them to mean the maximum and minimum widths of film that would ever be encountered under any circumstances. The manufacturers of equipment soon learned by experience that film would often be found considerably narrower than the standards. This fact was properly interpreted to be due to the shrinkage of the film. Whenever equipment manufacturers found film to be wider than the standards, they assumed that the film was improperly slit. They did not fully realize that film swells at high humidity and that film, even though properly slit, might swell under high humidity conditions so that its width would be greater than standard.

One reason why this swelling effect was not better known was because of the rapidity of shrinkage which occurred with the old type of high-shrink film. As soon as the package was opened (or even before this in case it was not adequately, hermetically sealed in a metal container) the film started to lose residual solvents and to shrink. This loss of solvents was more rapid at high humidities. Under most circumstances, therefore, the increase in width due to absorption of moisture from the air was more than counterbalanced by the decrease in width caused by loss of solvents to the air. For this reason it was rarely found in practice that film would be

Presented on October 8, 1952, at the Society's Convention at Washington, D.C., by Dr. E. K. Carver, Kodak Park, Eastman Kodak Co., Rochester 4, N.Y.

wider than the original slit width and, therefore, manufacturers of equipment began to consider that the standards represented the maximum that they would ever encounter. There was a tendency, therefore, to construct film gates and other equipment so that they would pass film with a width of 0.630 in. (16.0 mm) but of no greater width. They felt that any film which exceeded this width must be nonstandard film.

During the past ten or fifteen years film manufacturers have found means to improve the shrinkage characteristics of film and can be expected to make further improvements. Severe conditions which might cause the older type of film to shrink about 1% would cause the newer type of film to shrink only 0.2 to 0.4%. The present film often reaches the camera with no shrinkage whatever. There is not much difference, however, between the amount of swell due to absorption of moisture that occurs with the newer type of film and that which formerly occurred with the older type of film. It thus has become much more common to find the newer type of film wider than standard. Since much of the equipment has been constructed so as not to accept film with a width appreciably greater than 0.630 in., complaints have arisen that the film was slit too wide.

These complaints forced the film manufacturers to change the setting of their slitting knives from about the middle of the standard tolerances down to a point near the narrowest tolerances allowed. Accidental variations in slitting meant that some of the film was slit narrower than the allowed tolerances but no complaints were ever received for that reason. Complaints were still received, however, on film which appeared to be too wide at high humidities. The slitting knives were set still closer to the bottom tolerance. This practically eliminated complaints from film which was too wide but did not introduce any complaints or any difficulties from film which was too narrow. This was true even though a large fraction of the film fell below the "standard" width.

An investigation was undertaken to find out what the widths have formerly been at the time the film was actually used. Statistical studies were made on many samples of film purchased on the open market and of film at the end of its useful life. Measurements were also made in 16mm film exchanges of the regular, professional distribution systems. The various measurements showed clearly that the newer type film even with a reduced slitting width typically would reach the customer with a greater width than old type film. However, the width was not great enough so that one could expect any more trouble at high humidities than have been previously encountered.

The present attempt to change the standard for slitting 16mm film, therefore, is merely an attempt to recognize in a formal manner the changes which the film manufacturers have been forced to make in order to avoid complaints and to give the customer film as near the old width as possible. We call this an effort to maintain the "status quo," which is what the ultimate user often needs.

The Film Dimensions Committee is anxious to make sure that all of the equipment manufacturers thoroughly understand this problem. If these manufacturers were to misinterpret the new standard and reduce the dimension of film gates, then we would be in serious trouble. Complaints of film jamming would increase. Pressure would be put on the manufacturers of film to reduce the width of their film. Competition would force some of them to do so, and then there would be pressure put on the standardizing bodies to reduce the standard width again to conform to the width actually in use. One change would follow another, leading to chaos.

Three methods have been proposed to revise the standard to take care of the above problem. One of them was

simply to change the slitting dimensions, i.e., the dimension A in the Standard, from 0.629 in. ± .001 to 0.628 in. ± .001. Objections were raised to this method of changing the standard because it was felt that many people would consider that this meant a true reduction in width of film *as it is used* and would, therefore, reduce the width of the projector gates, camera gates, printer gates, etc., with the results described above.

In order to avoid this difficulty, it was proposed that the Standard for dimension A be written 0.6285 in. ± .0015. This way of writing the dimension would lay claim to the greatest width of the previous standard, namely, 0.630 in., and yet would permit film manufacturers to reduce their slitting width as much as required so that their low-shrink film would not exceed the width of the high-shrink film as previously manufactured. This idea was rejected because some members of the Committee felt that it would make it appear as if the change might be intended to permit less accuracy in slitting width than heretofore.

For the above reasons the Film Dimensions Committee finally agreed to recommend two standards. The old standard was to be kept the same as previously except that an asterisk was to be inserted above dimension A referring to the statement "For low-shrink film dimension A should be 0.628 in. ± .001 and dimension E, 0.0355 in." A definition for low-shrink film was included in the standard. The above method appeared to our Committee to take care of the difficulty in a fairly practical way, and this is the standard that is being recommended to ASA.

On the 9th and 10th of June at a meeting of Technical Committee No. 36 (Cinematography) of the International Standards Organization (ISO) this matter was further discussed. The three propositions as outlined above were placed before the Committee. The members of the Committee were unanimous in agreeing that some actual change in slitting should be adopted. The British delegates were insistent that their standards body would never accept different standards for high-shrink and low-shrink film and that they could not accept the increase in tolerance. The only one of the three proposals which they would accept was the reduction in the standard as outlined in the first of the above propositions with an additional statement somewhat as follows:

"Experience shows that it is common for film to expand when exposed to high relative humidity. Allowance should be made for this factor in equipment design and in no case should the equipment design fail to accommodate a film width of 0.630 in., 16.00 mm."

Rather than see the matter deadlocked, the American group as well as the French and German groups agreed to this modification. Most of us felt that all three proposals were identical in actual content and that any one of them would be satisfactory as an International Standard although we still preferred our own choice for the American Standards.

The actual standards covered by the work of the Committee are: PH22.5, 16mm Double Perforation; PH22.12, 16mm Single Perforation; and PH22.93, 35mm Low-shrink Film. These have been submitted by this Committee to the Standards Committee of the Society. It might be mentioned that the standards for 35mm low-shrink film intended to be used as camera raw stock do not call for a narrowing of the width, nor for other changes that seem quite logical from the point of view of shrinkage alone. The reason for this is that no changes have been made, however logical they may seem, without consulting the people in the trade who are using the film every day. This policy of considering the needs of the user is very desirable in simplifying the procedures and in preventing what might possibly be unnecessary or undesirable changes

Optics Committee Report

By RUDOLF KINGSLAKE, Committee Chairman

The Committee has completed its study of the Photometric Calibration of Lens Apertures (published Oct. 1952 for 6-month trial and comment), the final report being now in the hands of the Standards Committee for further action.

American Standard Z22.53-1946, "Method of Determining the Resolving Power of 16mm Motion Picture Projector Lenses," was submitted to the Committee for revision. Three small changes in wording were made which, however, do not affect the fundamental procedure in any way. This Standard has been approved by the Standards Committee for reissue and is currently being reviewed by ASA Sectional Committee PH22.

The next project to be undertaken by the Optics Committee is an attempt to standardize the physical dimensions of motion picture projection lenses. Tentative drawings have been issued showing the proposed outline boundaries between projector and lens, covering two sizes of 16mm lenses and two (or three) sizes of 8mm lenses. Copies have been sent to all known manufacturers of 8mm and 16mm lenses and projectors, and to members of the 16mm and 8mm Motion Pictures Committee, in the hope that a set of dimensions will be reached which will be acceptable to the whole industry.

A report dated August 18, 1952, prepared by Committee Chairman Rudolf Kingslake, Hawk-Eye Works, Eastman Kodak Co., Rochester 4, N.Y., for presentation on October 7, 1952, at the Society's Convention at Washington, D.C.

American Standards—

PH22.83-1952, PH22.38-1952 and Z22.33-1941

In October 1952, the American Standards Association approved one new standard, approved revision of a second standard and withdrawal of a third.

The new standard, PH22.83-1952, Edge Numbering 16mm Motion Picture Film, was published for trial and comment in the January 1951 *Journal*.

Since the change in PH22.38-1952 (formerly 22.38-1944) was so minor, consisting merely of the addition of a note, it was not considered necessary to publish the proposed revision for a trial period. The above two standards are the product of the 16mm and 8mm Motion Pictures Committee and are published on the following pages.

Approval has been withdrawn from the ASA Recommended Practice, Z22.33-1941, Nomenclature for Electrical Filters. This recommended practice was initiated by the Motion Picture Research Council as an outgrowth of some work on theater equipment. It was thought at the time that this method of designating electrical filters would be helpful in the motion picture field. It was useful for a while but has not been so for some time; therefore the SMPTE Sound Committee with the approval of the MPRC initiated withdrawal action about a year ago.—*H. K.*

Correction—

PH22.80-1950 and PH22.81-1950

An error has recently been discovered in two American Standards, Scanning Beam Uniformity Test Film for 16-Millimeter Motion Picture Sound Reproducers (Laboratory Type), PH22.80-1950 and (Service Type), PH22.81-1950, approved in June 1950 and published in the July 1950 *Journal*. The sound track width was given as 0.070 inch instead of 0.072 inch.

These standards are now being reprinted by ASA and republished here on pages 430 and 431.

American Standard

Edge-Numbering 16-Millimeter Motion Picture Film

ASA
Reg. U. S. Pat. Off.

PH22.83-1952

*UDC 778.5

1. Purpose

1.1 The purpose of this standard is to establish a uniform practice with respect to the interval between edge numbers when they are latent-image printed on 16-mm raw stock film. It is not intended to imply that all 16-mm film should be edge-numbered.

2. Edge-Numbering Distance

2.1 The distance between consecutive numbers shall be 40 frames. Thus, the numbers will indicate film footage, subject to a small correction for shrinkage of the film.

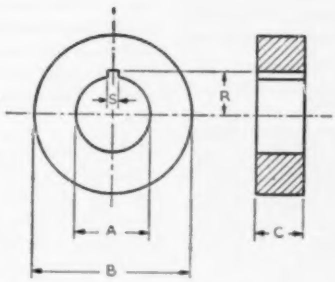
Approved October 8, 1952, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

American Standard

Raw Stock Cores for 16-Millimeter Motion Picture Film

Reg. U. S. Pat. Off.
PH22.38-1952
Revision of
Z22.38-1944
*UDC 778.5



	Millimeters	Inches
A	25.90 ± 0.20	1.020 ± 0.008
B	50.00 ± 0.25	1.968 ± 0.010
C	15.50 ± 0.50	0.610 ± 0.020
Recommended Practice		
R	16.70 ± 0.30	0.657 ± 0.012
S	4.00 ± 0.20	0.157 ± 0.008

Bore A to fit freely to hub 25.40 ± 0.1 mm or 1.000 ± 0.004-inch diameter.

It is permissible to reduce the cross-sectional area and to provide a slot in the periphery to facilitate starting the film on the core, so long as these details do not interfere with the stated dimensions. Except for the slot and keyway, the periphery and bore should present smooth, unbroken surfaces.

Approved October 8, 1952, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

American Standard

Scanning-Beam Uniformity Test Film for 16-Millimeter Motion Picture Sound Reproducers (Laboratory Type)

ASA
Reg. U. S. Pat. Off.
Z22.80-1950
*UDC 778.534.4

1. Scope and Purpose

1.1 This standard describes a film which may be used for determining the uniformity of scanning-beam illumination in 16-mm motion picture sound reproducers. The recorded sound track shall be suitable for use in laboratories and factories.

2. Test Film

2.1 The film shall be a print from an original negative. It shall consist of a 1000-cycle, variable-area recording at full modulation of the 0.005-inch width and shall be approximately sinusoidal. The track shall move uniformly 0.067 inch from one edge of the scanned area to the other as shown in Fig. 1.

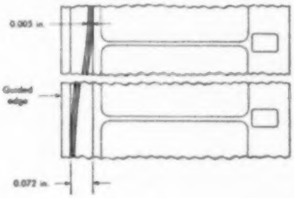


Fig. 1

2.2 The position of the sound track relative to the ends of the light beam at any instant shall be shown by a diagram appearing in the picture area, the size and location of which is shown in American Standard Location and Size of Picture Aperture of 16-Millimeter Motion Picture Cameras, Z22.7-1950, or any subsequent revision thereof approved by the American Standards Association, Incorporated.

2.3 The scanned area shall comply with the American Standard Sound Records and Scanning Area of 16-Mm Sound Motion Picture Prints, Z22.41-1946, and the film stock used shall be cut and perforated in accordance with American Standard Cutting and Perforating Dimensions for 16-Mm Sound Motion Picture Negative and Positive Raw Stock, Z22.12-1947, or any subsequent revisions thereof approved by the American Standards Association, Incorporated.

2.4 The length of this film shall be approximately 34 feet.

NOTE: A test film in accordance with this standard is available from the Motion Picture Research Council or the Society of Motion Picture and Television Engineers.

Appendix

(This Appendix is not a part of this American Standard.)

Before using the above test film it is recommended that correct placement of the scanning beam be determined by means of buzz-track test film as specified in American Standard Specification for Buzz-Track Test Film for 16-Mm Motion Picture Sound Reproducers, Z22.57-1947, or any subsequent revision thereof approved by the American Standards Association, Incorporated.

The uniformity of scanning beam illumination may be measured by means of a db meter connected to the output of the sound projector amplifier. The illumination of the scanning beam should be adjusted according to the instructions furnished by the manufacturer and the variation of the output as registered on the db meter should be observed. The illumination is considered satisfactorily uniform when the output reading as measured by the meter is within ±1½ db across the entire scanning slit.

Approved June 12, 1950, by the American Standards Association, Incorporated

Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

American Standard

Scanning-Beam Uniformity Test Film for 16-Millimeter Motion Picture Sound Reproducers (Service Type)

ASA
Reg. U. S. Pat. Off.
Z22.81-1950

*UDC 778.534.4

1. Scope and Purpose

1.1 This standard describes a film which may be used for determining the uniformity of scanning-beam illumination in 16-mm motion picture sound reproducers. The recorded sound track shall be suitable for use in the routine maintenance and servicing of the equipment.

2. Test Film

2.1 The film shall be a print from an original negative. It shall consist of a 1000-cycle, variable-area recording at full modulation of the 0.005-inch width and shall be approximately sinusoidal. The track shall move uniformly 0.067 inch from one edge of the scanned area to the other as shown in Fig. 1.

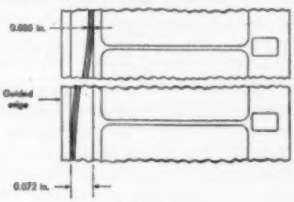


Fig. 1

2.2 The position of the sound track relative to the ends of the light beam at any instant shall be shown by a diagram appearing in the picture area, the size and location of which is shown in American Standard Location and Size of Picture Aperture of 16-Millimeter Motion Picture Cameras, Z22.7-1950, or any subsequent revision thereof approved by the American Standards Association, Incorporated.

2.3 The scanned area shall comply with American Standard Sound Records and Scanning Area of 16-Mm Sound Motion Picture Prints, Z22.41-1946, and the film stock used shall be cut and perforated in accordance with American Standard Cutting and Perforating Dimensions for 16-Mm Sound Motion Picture Negative and Positive Raw Stock, Z22.12-1947, or any subsequent revisions thereof approved by the American Standards Association, Incorporated.

2.4 The length of this film shall be approximately 3½ feet.

NOTE: A test film in accordance with this standard is available from the Motion Picture Research Council or the Society of Motion Picture and Television Engineers.

Appendix

(This Appendix is not a part of this American Standard.)

Before using the above test film it is recommended that correct placement of the scanning beam be determined by means of buzz-track test film as specified in American Standard Specification for Buzz-Track Test Film for 16-Mm Motion Picture Sound Reproducers, Z22.57-1947, or any subsequent revision thereof approved by the American Standards Association, Incorporated.

The uniformity of scanning beam illumination may be measured by means of a db meter connected to the output of the sound projector amplifier. The illumination of the scanning beam should be adjusted according to the instructions furnished by the manufacturer and the variation of the output as registered on the db meter should be observed. The illumination is considered satisfactorily uniform when the output reading as measured by the meter is within ±1½ db across the entire scanning slit.

Approved June 12, 1950, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

72d Convention, October 6-10

This was a very large and successful convention. We have not developed a whole schedule of comparative statistics for recent conventions and we doubt the prospects of pay dirt in such a vein, for each convention has possibilities and successes peculiar to itself. Such a large and successful convention was nicely fitting as the last convention under Bill Kunzmann, retiring Convention Vice-President. Joe Aiken, as Program Chairman and Local Arrangements Chairman, made the most of the Society's going organization and momentum to build a papers program and he organized the multitude of local arrangements for responsible help by the many capable people in Washington who contributed very generously to the Convention.

A particularly identifiable aspect of the Convention was the seven sessions which comprised the International Symposiums on High-Speed Photography which John Waddell began to promote and develop about a year and a half ago. The success and the breadth of the Symposium were almost entirely the result of John Waddell's work, with associates on the High-Speed Photography Committee coming through with papers and with Joe Aiken anxiously watching and finally arranging the program and meeting facilities for the roster of papers as it rolled up to an unprecedented volume.

Mrs. Nathan D. Golden and Mrs. Joseph E. Aiken, cohostesses for the Ladies' Program, prepared a unique program which brought out 240 ladies for events which included a tea and reception by Mrs. Truman at the White House, the Society's 72d Semiannual Cocktail Hour, Banquet and Dance, a luncheon at the Columbia Country Club, an evening at the Academia of the Motion Picture Association of America, and a tea at the Greek Embassy.

Special arrangements were made by Max Beard for about 130 visitors to attend the session on Thursday Afternoon at the Naval Ordnance Laboratory, White Oak, Md. SMPTE members were welcomed by R. D. Bennett, Technical Director of the Laboratory, who explained the Laboratory's place in the defense program. The Signal Corps Mobile Television System brought the audience a view of certain outlying areas by microwave relay and television receivers. Shock waves in the supersonic wind tunnel were demonstrated.

Hotel and transportation arrangements were locally under Henry Fisher who made arrangements especially helpful for visitors from overseas and also facilitated the extensive program arranged for the ladies. Gerald J. Badgley was active in membership promotion along with Ray Gallo, Chairman of the Society's Membership Committee. Jim Moses gave a welcome assist as a Washington member to Len Bidwell who came from Camden for a customary stint of getting out a big week's worth of Convention publicity.

Under Convention Vice-President Kunzmann, convention registration was organized for Washington by Keith B. Lewis who had the assistance of Phil Cowett, Fred Gerretson, Max Kerr, Jim Moses, Bill Nagel and Howland Pike. This was a real job considering that, along with the tabulation of registration which follows, also to be dispensed were tickets for two luncheons, the banquet, the bus trip to the Naval Ordnance Laboratory, and theater passes and information. This was the way registration for the technical program went:

	Weekly	*Daily*	*Total*
Monday	241	35	276
Tuesday	58	85	143
Wednesday	33	165	198
Thursday	—	129	129
Friday	—	114	114
Total	332	528	860

Projection service for the sessions was organized by Carl Markwith with assistance by William Hecht, Wilson E. Gill, Ralph Grimes, William Youngs and Glen Ornstine. They supplied 16mm and 35mm

equipment for the technical sessions and also met the demands of five pairs of concurrent sessions. Public address and recording of discussion — of which there was a good deal — was under the direction of Jack Greenfield who had the assistance of Robert Dickinson, Richard Simpson, Mike Loria, and Ed Moore who was most effective in stepping into a late schedule for recording some high-speed photography papers, with equipment supplied by Wilson E. Gill.

Further refinements in the Society's public address and recording equipment may be forthcoming. Editorial Vice-President-elect Norwood Simmons has appointed the following committee to study the equipment: George Lewin as Chairman, Edwin A. Dickinson, Jack Greenfield and Fred Whitney.

Motion pictures for the opening of sessions were garnered and made into a coordinated film program by John V. Waller who was assisted by John E. Horton, Jack McCullough and Emerson Yorke. The roster included:

Jet Test, 16-B&W, Air Force

Timber & Totem Poles, 16-color, U.S. Dept. of Agriculture

This Theatre & You, 16-B&W, Motion Picture Assn.

Operation Greenhouse, 16-color, Atomic Energy Com.

School for Dogs, 35-B&W, RKO

Screen Actor, 16-B&W, Motion Picture Assn.

Shining Rails, 16-color, Gen. Electric

Gambling, 16-B&W, Navy

Small Town Editor, 16-B&W, State Dept.

Shoemaker & The Hatter, 16-color, Mutual Security Agcy.

Costume Designer, 16-B&W, Motion Picture Assn.

Representative Instructional Films, 16mm Maint., Various

Arch Against The Sky, 16-B&W, Gt. Lakes Steel Corp.

Unlocking The Atom, 16-B&W, Universal

Let's Go To The Movies, 16-B&W, Motion Picture Assn.

Tanglewood, 16-B&W, State Dept.

Screen Writer, 16-B&W, Motion Picture Assn.

There were more persons than usual from overseas, many of them coming for the International Symposium on High-Speed Photography (see photo). A highlight of the Symposium was the High-Speed Photography Luncheon on Wednesday noon when A. C. Keller spoke on "The Economics of High-Speed Photography" which is published elsewhere in this *Journal*. John Waddell was master of ceremonies to welcome an overflow crowd in the luncheon hall. There were several of the Society's officers and Governors at the High-Speed Luncheon. John Frayne, Editorial Vice-President, spoke briefly about the accomplishments of the High-Speed Photography Committee and assured the High-Speed photographers of the Society's continuous policy to help in every way possible, believing that the interests and activities of high-speed will be served well within the Society's organizational structure which permits integrated activity of varying but related interests and which at the same time brings the benefits of mutually sharing in facilities, overhead and man-hour costs.

It was of some interest to note not only at the High-Speed Luncheon but also at the high-speed paper sessions that a sizable fraction of those attending had registered for the entire week and also that quite a few persons shuttled between high-speed and the concurrent session in order to hear particular papers. This may or may not be an indication of greater diversification of high-speed people's interest, to include phases of laboratory practice, optics or sound.

The highest attendance at a session was 247 on Tuesday afternoon for Karl Freund's paper "Shooting Live Television Shows on Film." It was read by John Boyle in the absence of the author who is currently on a rigid four-days-a-week Hollywood television schedule. The paper was tainted with entertainment possibilities by showing on a sizable screen a film of *I Love Lucy* which demonstrated the cameraman's problem.

The only other sessions to draw over 200 were two of the seven sessions of the International Symposium on High-Speed Photography. During the high-speed sessions there was some filing in and out for particular papers but, during the first two

Five of the world's foremost specialists on high-speed photography discuss program for largest international symposium on the subject at the 72d Semiannual Convention. Left to right: Dr. Hubert Schardin of Weil Am Rhein, Baden, Germany, Director of the French Ordnance Laboratory at St. Louis, France, and world authority on ballistics photography; Dr. Carl Jennergren, of the research staff of the Swedish Ordnance Laboratory at Stockholm; W. D. Chesterman, of the Royal Naval Scientific Service in London, author of the first English text on high-speed photography; Gilbert Ruellan, Managing Director of the Andre Debrie Establishment, French manufacturers of motion picture equipment; and Major P. Naslin, of the research staff of the French Ordnance Laboratory of Vincennes, co-author of the world's first text on high-speed photography, published in 1950.

days of high-speed, attendance held to an average of 150. By Friday apparently even the high-speed photographers' fibers and capacities were taxed, for then attendance averaged 80.

The Monday evening television session and the Thursday evening 16mm maintenance sessions held the rapt attention of about 80 throughout. Other sessions not previously mentioned ranged from 125 to 175.

There were fourteen committee meetings held during the Convention, many of them lasting for several hours. Reports of these appear in the Engineering Activities column in this *Journal*.

The Luncheon and Banquet were organized by Nate Golden who put them on with a strict schedule. The awards presented at the Banquet will be described in the December *Journal*. Nate Golden arranged for speakers from the three service branches. Their remarks before the Get-Together Luncheon were impressive and warmly received. The speeches are abstracted below. One of Joe Aiken's special plans for this Convention was to feature the Signal Corps Mobile Television Unit. This and other television plans were under Ralph N. Harmon and Col. C. S. Stodter. W. P. Dutton was most helpful in the planning but unfortunately was ill at Convention time. The Get-Together Luncheon program was picked up by the Signal Corps Mobile Unit and sent to the Pentagon. The program included speeches abstracted as follows:

Ranking photographic authorities of the Army, Navy and Air Force confer with Peter Mole (second from left), President of the Society of Motion Picture and Television Engineers, on luncheon program opening the Society's 72d Semiannual Convention at the Hotel Statler, Washington, D.C. The military experts, who were guest speakers at the luncheon, are (left to right) Major General George I. Back, Chief Signal Officer of the Army; Brig. Gen. Brooke E. Allen, Chief of Staff of the Military Air Transport Service and, until recently, Commanding General of the Air Photographic and Charting Service of the Air Force; and Capt. A. D. Fraser Chief of Naval Photography in the Office of the Chief of Naval Operations.

Get-Together Luncheon Remarks by President Mole

A short time ago I had occasion to review the history of engineering in the motion picture industry, and I was reminded repeatedly of the mature judgment and wisdom that our predecessors in this Society had contributed to the progress of motion picture technology. They played an important part in the development of sound and color motion pictures and standardization, all of which are commonplace today.

We are on the threshold of another era of progress. I am sure we will all agree that the movies and television can not only live together but can supplement and strengthen one another. The record of cooperative engineering within our Society, which extends across both fields, is already an impressive one, and through such efforts we have sounded a note of profound encouragement for both the economic and the technical future of the field in which most of us make our daily living.

This week here in Washington, some of our most distinguished members will be discussing questions of serious importance to the future of theater television. Last week a significant event occurred when Cinerama, a development many years in the making, was first demonstrated to the public in New York. The week before, large-screen theater television enabled thousands from coast to coast to witness the championship bout between Rocky Marciano and Jersey Joe Walcott. More people saw the telecast in movie theaters than were actually in attendance at the fight. Now, none of us can predict in exactly what direction theater television will develop. Nor can we foretell the future of Cinerama, or that of the several new systems of motion picture color.

But one thing is *certain* — these technical developments and the excitement they have created, within and outside our field of professional engineering, are together the most encouraging symptoms to appear in the past ten years. They are evidence of a new, widespread, and healthy interest in the technical future of both motion pictures and television. I sincerely hope they will spark a chain reaction that will eventually stimulate each one of us, working together in this Society, to accomplishments greater than any we have yet attained.

Excerpts From Address by Gen. George I. Back

It is a distinct pleasure for me to join with you at the opening session of your 72nd Semiannual Convention and to be given the opportunity of presenting some of my thoughts regarding motion pictures and television within the Army.

Broadly speaking, the Signal Corps, in keeping with its responsibility for providing an integrated communications system for the Army, must be prepared to transmit information (or what we call intelligence), whatever its form may be. This intelligence may be transmitted as the spoken word, the written message, or in the form of a pictorial representation. It may be directed to a single person or to several addressees at different places throughout the world. It may also be intended for mass distribution to thousands.

In the process of transmission, intelligence may take many and varied forms as it is transformed through electronic, mechanical magnetic or photographic processes. But whatever the processes employed, they must be designed to provide a thoroughly integrated, but flexible, system which will deliver the message accurately and rapidly.

The motion picture has served the Army well through two world wars. The sound motion picture is doing the same important job in the Korean conflict, as a medium for training our forces, as a means for promptly acquainting the American public with our operations in combat, and finally as a means of pictorially documenting military history as it is written. Of possible interest is the fact that seventy million man-hours of military training are accomplished annually by the Army through the use of training films. Furthermore, many of these films are extensively used by our allies after the script has been rescored in the appropriate language, thus creating a unity of military thinking and a better understanding of mutual security problems. Similarly, in the field of research and development of military equipment, methods and tactics, the motion picture has become an irreplaceable tool, since it provides a means for repeated analytical study of critical phases of a given operation, whether it be a military maneuver or the testing of such weapons as the atomic bomb or the guided missile.

While military applications of the sound film continue to multiply, television has become available as another medium for the transmission of sound and pictures, a medium which offers tremendous possibilities with its potential of speed and accuracy. Although the full military possibilities of television have not yet been determined, we have for some time been engaged in exploring its manifold applications. In this work we have been guided by our past experiences in the pictorial communication field. Many possible applications for military television suggest themselves. To mention but a few:

Distant tactical observation of military positions and actions from the ground and air.

Bringing distant or relatively inaccessible subjects into many training classrooms simultaneously.

The tactical briefing of widely separated commanders.

Guidance and control of land vehicles and light aircraft.

Close-up observation of the action and effect of our weapons.

Mass dissemination of important information in pictorial form to reserve and civilian components of the armed services and to the public at large.

These are only a few of the suggested fields of employment. I believe, however, that they indicate the trend of military thinking toward full utilization of this new method of communication.

Incidentally, the Signal Corps is pleased to be able to bring to this convention the Mobile Television System which is being used in our fundamental explorations of television's possible military applications. This equipment embodies much of the engineering skill which you engineers have contributed to the development of the television medium and emphasizes the spirit of scientific cooperation that exists between your industry and the Signal Corps. Needless to say, we in the Army are grateful to you for the splendid assistance we are receiving from you.

I should like to point out here that the Army has recognized the need for complementary development and utilization of television and sound motion pictures in order to obtain the maximum effectiveness of both media, just as you engineers have recognized that the two are complementary and compatible, rather than exclusively competitive. Only television can reproduce an event at a distant point instantly, but only motion pictures can record and retain the image of that event. By combining the electronic immediacy of television with the photographic retentiveness of the motion picture, we can have available to us the maximum facility possible in pictorial communication. For this reason, the Army has placed the responsibility for development of both media in the hands of the Signal Corps, thus assuring full coordination in their development.

In closing, I should like to appeal to you for continued assistance and cooperation in the research and development field in both sound motion pictures and television. This is essential if we are to provide our combat forces with the best that industry can produce. By that I mean techniques and equipment which will insure complete reliability under field operating conditions, optimum performance characteristics consistent with the state of the art, and reasonable cost under conditions of mass production. Any lesser goal will not be good enough.

Excerpts From Address by Gen. Brooke E. Allen

. . . . The Air Force is privileged to have both in uniform and as civilians members of your distinguished Society. The closer our association with you the easier it will be to accomplish our job for the Air Force. Be assured that we fully appreciate the accomplishments of the scientists, the engineers and the technicians in your field, and we gladly join ranks with you and propose to do our full share toward the advancement of the art.

When I received my invitation to speak to you, I was in command of the Air Photographic and Charting Service, which constitutes one of the family of operational services under the Military Air Transport Service. Shortly thereafter I was transferred to my present position as Chief of Staff of the Military Air Transport Service.

Since it was my responsibility to establish the Photographic Service, it is close to my heart, and I could not possibly forego a chance to explain its missions and aims to you.

I should like to go back a bit in order to get the record straight. Photography since its inception has been vitally important to the military. Aerial photography began to have meaning when intelligence photographs were laboriously taken from captive balloons in the war between the states. A century ago, an ingenious Frenchman made a map of Paris on the basis of photographs taken from a balloon. Out of that simple beginning grew the science of military photography.

The development of motion picture photography has made it possible to document photographically the live action of the battlefield, on land, on the sea and in the air. The vital military importance of such a photographic record is obvious, just as every football coach insists on a motion picture record of Saturday's game for Monday's critique.

Under the Unification Act of 1947, the Department of the Air Force was given complete responsibility for its own photographic functions. This did not, however, result in the automatic establishment of a satisfactory organization to perform those functions.

Instead, the photographic responsibility became scattered among the major air commands without overall control,

supervision or coordination. This was simply one of the growing pains connected with the establishment of the Air Force as a separate Department along with the Army and the Navy.

It was not strange, therefore, that the outbreak of hostilities in Korea found the Air Force unprepared to meet its photographic requirements in an efficient and organized manner. The Army and the Navy, on the other hand, were well prepared to document their combat activities with photography, so essential for operational purposes. When the Chief of Staff of the Air Force became aware of the situation, he directed the immediate establishment of a photographic service to satisfy the most urgent requirements of the Air Force.

After almost a year of careful study and planning, the scattered but related activities of the Air Force were reorganized under a single command, which was designated the Air Photographic and Charting Service. The principal elements of the Photographic Service are:

The Photographic Documentation Group;
The USAF Photographic Center;
The Mapping and Charting Group; and
The Aeronautical Chart and Information Center.

The units of these activities are of necessity scattered from Korea through Europe, to North Africa and the Middle East. Wherever the global mission of the Air Force requires its operation, there also you will find units of the Air Photographic and Charting Service.

I should like to emphasize that during the year in which the Photographic Service was being organized and firmly established, photography did not stand still. During that first year our Combat Camera Unit in Korea piled up over 300 combat missions and exposed more than 225,000 feet of motion picture film in combat. The Unit ran up an outstanding record of awards and decorations and took their combat losses along with the fighting units.

Today we are happy to fall in step with the pace set by you television engineers. We have brought the field of electronics into a firm position in our organization. Indicative of how we are accomplishing this in the Photographic Service is the fact that the production division has a split title. It is called the Motion Picture and Video Production Division. In this Division we have affected a marriage of these two fields without any of the initial rivalry that ran through industry when the motion picture and the television people first eyed each other warily from opposite sides of the fence.

It was a matter of firm pride to think that I was connected with the creation of a video production unit in the Air Photographic and Charting Service. The mission of this unit is built around the high-speed concept, completely mobile with the latest electronic equipment. This unit is now undergoing the equipping phase prior to an operational shakedown.

It was established on an experimental basis to ascertain as early as practicable the applicability of television to the operational and training mission of the Air Force. Part of their portable equipment is a 16mm rapid processor which was first presented, I believe to the Society at your convention in Chicago in April 1950. As you know, this machine presents a ready-to-project print beginning ninety seconds after initial photography.

As the author of any new work takes great pride in crediting his source material, we do so with a bow of great appreciation to industry and to our elder services — the Army and Navy. Throughout all of our efforts, we have maintained liaison with industry, with the experiments conducted by the universities and colleges throughout the country and the work done by the Navy in its Special Devices Center at Sands Point and, of course, with the Army's "Operation Caravan."

No great degree of imagination is required to see unlimited possibilities in the application of TV to technical, flight and combat crew training, and through kinescope recordings the preparation of training films with celerity and informality hitherto impossible. What we lose in artistry, we gain in speed and volume.

I have given you a rough sketch — yesterday, today and tomorrow — of photography and television in the Air Force. Your meeting here in Washington seems to key note high-speed. In the Air Force we are trying to keep our thinking and our planning in that same key — to keep the pace that you are setting.

In discharging its global mission in photography and television, the Air Force is seeking every means to get information faster and better and to put it to its maximum use in the shortest time. As you television engineers know the television circuit can be the shortest and speediest route from live action to finished film. This is of major importance to us today. As you engineers come up with new methods, new techniques, faster and better ways to accomplish our mission, you can be sure that the Air Force matches your zeal with our own desire. We are proud to serve with you in the search for better ways of getting the job done.

It is a constant but exciting challenge. We are happy to be able to join you in it. As for the future, the course seems clear ahead of us. To coin a phrase, we have now become airborne and over our first and most difficult obstacles. As for the rest, the horizons are unlimited.

Excerpts From Address by Capt. A. D. Frazer

. . . . In the Navy, we use motion pictures extensively and the requirements for the use of television are continually expanding.

Entertainment motion pictures provide probably our greatest morale booster. Every ship and station has movies and I can tell you from personal experience that when the movies do not arrive or they cannot be shown for some reason the boys are very unhappy. We are, of course, dependent on the motion picture industry for these films and are deeply appreciative of the service provided and the technical improvements that have been made to give us better sound and color for the adverse conditions encountered in shipboard screenings.

In our military use of motion pictures, the largest single requirement is in the field of training films. We also use them extensively for test and evaluation of new equipment. This is especially true in the guided missile program where high-speed motion picture photography has become most valuable.

Recording of Naval operations for historical purposes and evaluation is of great importance. There is a growing need for motion pictures in combat briefing.

Boat crews that have to approach a hostile beach during an amphibious operation can learn a great deal from seeing movies of the beach area made previously.

[Capt. Frazer spoke briefly of the Navy's training film program — this was described in detail by Cronenwett and Timmons in the July 1952 *Journal*.]

In the development and test of new equipment, motion pictures have proven to be invaluable. This has been particularly true in the evaluation of equipment that operates faster than the eye can follow or the mind record. A few examples are:

Wind tunnel tests of sonic and transsonic airfoils;

Instrument recordings of tests of new aircraft;

Recording of instrument readings of tele-metered flights of guided missiles;

Determination of explosion;

Phenomena of new types of weapons and explosives and their effect on naval equipment; and

Verification of proper sequence and operation of a series of functions in various mechanical and electrical devices.

Many of these uses will be discussed in detail in later sessions of your Convention.

On our larger ships, and especially in aircraft carriers, we have motion picture camera equipment for recording various aspects of naval operations. These are used for historical recording, and for study to improve the execution of various maneuvers and to detect deficiencies in equipment.

Training in the basic techniques of motion picture photography is given to all students at the Navy's photo school at Pensacola, Florida. A specialized course at the same location is also conducted for a limited number of advanced students.

The motion picture industry in Hollywood very generously operates a comprehensive on-the-job training course for selected personnel. This program has proven to be most beneficial and provides a phase and completeness of instruction that is not possible of attainment in a service school.

In the field of television, the Navy has

been active in development work since before World War II. Television control of drone aircraft was successfully demonstrated and used in the South Pacific by the Navy in 1944. More recently, as reported in the press, it has been used successfully in Korea.

The employment of television for Naval purposes opens many new possibilities. Improvement in the equipment will, however, be necessary. Needed are further reduction in size and weight of camera and transmitting equipment, and considerable improvement in reliability under very adverse operating conditions with substantial increase in reception distance. These requirements sound somewhat contradictory but I am confident that the industry can solve the problems.

Photo recording of television and cathode-ray tube images has been carried out in the Navy for some time. This utilization has progressed to the point where much of the work is done automatically. There is still room for progress, however, in the development of new and more sensitive emulsions and more rapid processing of these emulsions. Results obtained along these lines, to date, have been very gratifying. In the field of group instruction, television has been used experimentally and the Navy Special Devices Center is continuing study of this medium. Test instruction has been quite satisfactory and indicated a good percentage retention of transmitted information. Closed circuit, broadcast, and kinescope methods have been used in this program. The feasibility of using this system for briefing purposes and group instruction within task forces at sea is under development for evaluation.

The uses of television in the testing and examination of devices and equipment for naval employment are almost limitless. Small television cameras can be placed within equipment where it is physically impossible for a human observer to be under such conditions as: limitations of space, atmospheric conditions, high G forces, high temperatures, or severe vibration. There are many more.

The Navy is vitally interested in new developments in the field of television and motion pictures. Their parallel use holds great promise for the future. We look to the Society of Motion Picture and Television Engineers for future developments that will make past successes seem insignificant by comparison.

Engineering Activities

72d Convention Thirteen Engineering Committees held meetings at the 72d Convention in Washington, D.C., October 6–10. This in itself made for lively, efficient meetings. The schedule was tight and required the use of mornings, afternoons and evenings — including the "morning after" the Wednesday night banquet. On several occasions there was hardly time for the chairs to cool as one meeting adjourned and another was called to order. The meetings successfully furthered standards activity and provided opportunities for the exchange of "shop" talk.

Standards activity is at a very high level today. In addition to the development of new standards required by growth and changes in the industry, the Society is in the process of actively reviewing (in accordance with ASA rules) all standards currently over three years old. The highlights of this activity as discussed in the various committee meetings will be presented below and also in the December *Journal*.

Film Dimensions Dr. E. K. Carver, Chairman, was unable to be present and his alternate, Dr. A. C. Robertson, chaired the meeting. The status of active projects was reported as follows:

PH22.1, Alternate Standards for Positive or Negative 35mm Raw Stock Film — This proposal was published for trial in the September 1951 *Journal*, approved by the Standards Committee in July 1952, by ASA Sectional Committee PH22 and SMPTE Board of Governors in October 1952 and is presently before the Photographic Standards Correlating Committee.

The following three standards (two revised standards and a new proposal) were approved by the Film Dimensions Committee and are now being reviewed by the Standards Committee.

PH22.5, Dimensions of 16mm Silent Motion Picture Film,

PH22.12, Dimensions of 16mm Sound Motion Picture Film, and

PH22.93, Dimensions of 35mm Low Shrink Camera Raw Stock Film

The periodic review of standards has brought four standards up for consideration and it was agreed that three should be revised:

Z22.17-1947, 8mm Film Dimensions,

Z22.31-1946, Definition for Safety Film,

Z22.36-1947, 35mm Positive Film Dimensions;

and the fourth reaffirmed:

Z22.37, 1944, 35mm Raw Stock Cores.

Film Projection Practice This committee is similarly reviewing four standards and here it was also agreed that one should be reaffirmed:

Z22.4-1941, 35mm Projection Reels;

and three revised:

Z22.29-1946, Projection Rooms and Lenses,

Z22.35-1947, 35mm Sprockets, and

Z22.58-1947, 35mm Projector Aperture.

In addition several dormant projects, "Projection Room Plans," and "Arc-Lamp Mounting Dimensions," were discussed and plans made to reactivate them. Finally, the desirability of standardizing the Society Leader from both a television and a theater point of view was mentioned and initial action in that direction approved.

Films for Television This committee was largely responsible for the development of the Television Test Film. Much thought was given at this meeting to ways and means of further improving it and changes may be expected in the near future.

Standardization of the Society Leader was discussed at this meeting also. As was mentioned in the May 1951 *Journal*, this leader was developed by the Leader Subcommittee, chaired by Charles Townsend. It was designed to keep the basic features of the Academy Leader required by the theater projectionists while adding useful information required in projecting films for television. The Subcommittee was now asked to revise paragraph 3 of the Release Print Standard, Z22.55-1947, to incorporate use of this new all-purpose leader.

Laboratory Practice Some half dozen standards are being reviewed by this committee but discussion on them was tabled until returns on the letter ballot, issued a few weeks before the meeting, are more complete.

Instead the discussion revolved about two projects which have occupied the committee's attention for some time: (1) Screen Brightness in 16mm Laboratory Review Rooms; and (2) Printer Light Change Cueing. No fundamental differences exist about the latter and agreement was readily reached on a second draft soon to be circulated to the committee. Quite the converse is true of the former. Here there are two schools of thought, one holding that 16mm and 35mm screen brightness should be the same (9–14 ft-L) and the other arguing for a lower value (5–10 ft-L) in 16mm review rooms. The final decision was to issue a second letter ballot, this time setting forth the arguments for both positions and allowing for a choice of either set of values.

Screen Brightness The 16mm review room screen brightness proposal was also discussed here and with similar views expressed. This committee will receive the same letter ballot prepared for the LP Committee.

The Subcommittee on Instruments and Procedures submitted a final report of its findings. This was approved for *Journal* publication with but minor editorial changes.

Wallace Lozier, Chairman, reported on the status of the revision of the Screen Brightness Standard, PH22.39. This has run the gamut of approval within the SMPTE, was published in the May 1952 *Journal* for trial (no adverse comment was received) and is presently being reviewed by ASA Sectional Committee PH22—*Henry Kogel*, Staff Engineer.

New Members

The following members have been added to the Society's rolls since those last published. The designations of grades are the same as those used in the 1952 MEMBERSHIP DIRECTORY.

Honorary (**H**) Fellow (**F**) Active (**M**) Associate (**A**) Student (**S**)

Bader, David A., Writer, Journalist, Literary Associates. **Mail:** 147-66 Village Rd., Jamaica 35, N.Y. (**A**)

Ball, Howard D., Film Projectionist, Kennedy Broadcasting Co. **Mail:** Box 87, La Jolla, Calif. (**A**)

Del Rosario, Macario T., M/Sgt., U.S. Army, Qtrs. 111-C-1, Governors Island, New York 4, N.Y. (**A**)

Ellington, Frederick K., Theatre Circuit Maintenance Supervisor, Syndicate Theatres, Inc., Crump Theatre, Columbus, Ind. (**A**)

Epstein, Sidney, Electronic Engineer, S.O.S. Cinema Supply Co. **Mail:** 111 Tudor Pl., Bronx 52, N.Y. (**A**)

Hathaway, Henry R., Jr., Officer in Charge of Sound Recording Dept., U.S. Air Force. **Mail:** 1027 Columbia Dr., Bucknell Manor, Alexandria, Va. (**A**)

Heathcote, Bruce, SRT-TV Studios. **Mail:** 45-36 — 49 St., Woodside 77, N.Y. (**S**)

Henderson, John E., Projection Room Supervisor, Jefferson Standard Broadcasting Co. **Mail:** Sardis Rd., Charlotte, N.C. (**M**)

Maloof, Michael B., Jr., Audio Control Engineer, Paramount Television Productions. **Mail:** 1155 N. Heliotrope Dr., Los Angeles 29, Calif. (**A**)

Minor, M. J., Radio Engineer, Jefferson Standard Broadcasting Co., 508 Wilder Bldg., Charlotte, N.C. (**M**)

Navon, M., Director, Geva Films, Ltd., 32 Allenby Rd., Tel Aviv, Israel. (**A**)

Norling, Richard V., Motion Picture Technician, Byron, Inc. **Mail:** 12119 Edgemont St., Silver Spring, Md. (**A**)

Seitz, Henry J., TV Film Transmission, Columbia Broadcasting System. **Mail:** 89-18 Rutledge Ave., Glendale, L.I., N.Y. (**A**)

Sykes, Langthorne, Electronic Scientist, U.S. Naval Ordnance Test Station. **Mail:** P.O. Box 455, China Lake, Calif. (**A**)

Teitelbaum, Ben, Partner, Hollywood Film Co., 5446 Carlton Way, Hollywood 27, Calif. (**A**)

Teitelbaum, Harry, Partner, Hollywood Film Co., 5446 Carlton Way, Hollywood 27. (**A**)

Todd, Clayton S., Engineer, Metro-Goldwyn-Mayer Studio. **Mail:** 3354 Mills Ave., La Crescenta, Calif. (**A**)

Tyo, John H., Audio-Visual Center, Indiana University, Bloomington, Ind. (**S**)

Wallis, Gilbert, Project Engineer, Land-Air, Inc. **Mail:** 405 Deney La., Alamogordo, N.M. (**A**)

Zale, Ben, Editor, Industrial Photography, 1114 First Ave., New York 21, N.Y. (**A**)

CHANGES IN GRADE

Hu, Tsu-Ming, (**S**) to (**A**)

Stevenson, Murray H., (**A**) to (**M**)

Watermeyer, Erwin, (**A**) to (**M**)

DECEASED

D'Andrea, Matthew J., Free-Lance Technician. **Mail:** 18 Hudson Ave., Edgewater, N.J. (**M**)

Levinson, Nathan, Sound Director, Warner Brothers Pictures, Inc., Burbank, Calif. (**F**)

Pariseau, S. M., District Manager, Altec Service Corp. **Mail:** 1956 S. Vermont Ave., Los Angeles 7, Calif. (**A**)

Meetings

Society of Motion Picture and Television Engineers, Central Section Meeting (in conjunction with Society of Photographic Engineers), Dec. 3, Bell & Howell Co., Chicago, Ill.

American Institute of Chemical Engineers, Annual Meeting, Dec. 7-10, Cleveland, Ohio

American Institute of Electrical Engineers (Symposium on The Science of Music and Its Reproduction — 2d Lecture), Dec. 11, Engineering Societies Bldg., New York, N. Y.

American Society of Photogrammetry, Annual Meeting, Jan. 14-16, Shoreham Hotel, Washington, D. C.

American Institute of Electrical Engineers (Symposium on the Science of Music and Its Reproduction — 3d Lecture), Jan. 15, Engineering Societies Bldg., New York, N. Y.

Society of Motion Picture and Television Engineers, Southwest Subsection Meeting, Jan. 16, Dallas, Tex.

American Institute of Electrical Engineers, Winter General Meeting, Jan. 19-23, New York, N. Y.

American Physical Society, Annual Meeting, Jan. 22–24, Cambridge, Mass.
Institute of Radio Engineers Conference and Electronics Show, 5th Annual Southwestern Conference and Show, Feb. 5–7, San Antonio, Tex.
American Institute of Electrical Engineers (Symposium on the Science of Music and Its Reproduction — 4th Lecture), Feb. 20, Engineering Societies Bldg., New York, N. Y.
National Electrical Manufacturers Association, Mar. 9–12, Edgewater Beach Hotel, Chicago, Ill.
Society of Motion Picture and Television Engineers, Southwest Subsection Meeting Mar. 16, Fort Worth, Tex.
Inter-Society Color Council, Annual Meeting, Mar. 18, Hotel Statler, New York, N. Y.
Optical Society of America, Mar. 19–21, Hotel Statler, New York, N.Y.
American Physical Society, Joint Meeting with APS Southeastern Section, Mar. 26–28, Duke University, Durham, N.C.
American Physical Society, Apr. 30–May 2, Washington, D.C.
Acoustical Society of America, May 7–9, Hotel Warwick, Philadelphia, Pa.
Society of Motion Picture and Television Engineers, Southwest Subsection Meeting, May 20, Dallas, Tex.
American Physical Society, June 18–20, Rochester, N.Y.
American Institute of Electrical Engineers, Summer General Meeting, June 29–July 3, Atlantic City, N.J.
Biological Photographic Association, 23d Annual Meeting, Aug. 31–Sept. 3, Hotel Statler, Los Angeles, Calif.
The Royal Photographic Society's Centenary, International Conference on the Science and Applications of Photography, Sept. 19–25, London, England
Theatre Equipment and Supply Manufacturers' Association Convention (in conjunction with Theatre Equipment Dealers' Association and Theatre Owners of America), Oct. 31–Nov. 4, Conrad Hilton Hotel, Chicago, Ill.
Theatre Owners of America, Annual Convention and Trade Show, Nov. 1–5, Chicago, Ill.
National Electrical Manufacturers Association, Nov. 9–12, Haddon Hall Hotel, Atlantic City, N.J.

Employment Service

Positions Wanted

Audio-Visual School of Education Graduate: M.A., Audio-Visual Education, New York University. Sound background in personnel and contact work, attractive, single, personable. Prefer position New York or New Jersey area. Spent 3 years abroad, civilian, Special Services Director. Miss Fredericka Appleby, 810 Broadway, Newark, N.J. HUmboldt 5-4582.

TV Producer-Director: Formerly Chief of Production in Army's first mobile TV system, experience in writing-directing high-speed, low-cost instructional productions; TV producer-director, KRON-TV San Francisco, five shows weekly. Desire connection in educational TV, preferably employing kinescope technique; married; prefer West Coast, but willing to travel; résumé, script samples, pictures of work — on request. Robert Lownsbery, 1116 E. Claremont St., Pasadena 6, Calif.

Research, field engineering, manufacturing opportunity for B.S. Electrical Engineering candidate, Jan. 1953; Scholarship student, M.I.T.; studied in Germany, 1945–1950. Languages: German, Polish, Russian and English. Some radio shop experience; also M.I.T. Library and Engineering Dept. Single, no dependents; Military Status, 5A (over 26). Prefer location in East. Joseph Liebermann, 513 Beacon St., Boston, Mass.

Position Available

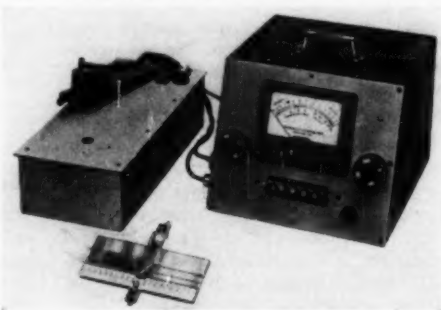
Wanted: Young engineer, mechanical or electrical deg; with liking for fine machinery and creating it, some experience in mechanical design and some knowledge of optics or electronics; for work on development of new products; applications held in full confidence. Send complete résumé to Sherman Fairchild and Assoc., Rm 4628, 30 Rockefeller Plaza, New York, Attn: Mr. Fairbanks.

New Products

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products.

Portable microphone boom, for studio or location work, has been made of aluminum tubing and bronze castings. It telescopes approximately 7 to 17 ft, has a balance weight at the rear of the boom that is adjustable for extension, and has a remote control allowing 360° rotation of the microphone by a universal angular control from the back. The boom dolly is a two-section telescoping unit with collapsible legs and ball bearing casters, with foot locks. The boom complete with stand collapses for portability and weighs about 100 lb. Further details are available from National Cine Equipment Inc., 209 W. 48 St., New York 19, N.Y.

The Photovolt Densitometer, a product of Photovolt Corp., 95 Madison Ave., New York 16, is a combination of a Model 520-A Multiplier Photometer, a Model 52 light source unit and a special guide attachment for 35mm and 16mm film strips. It is designed to measure color (and black-and-white) densities in very small spots in the image area as well as in ordinary and silver sulfide sound tracks. It is equipped also to read densities on sensitometric tablets.



SMPTE Officers and Committees: The roster of Society Officers and the Committee Chairmen and Members were published in the April *Journal*.

Society of Motion Picture and Television Engineers

Sustaining Members

OF THE

SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

Altec Companies
Ansco
C. S. Ashcraft Mfg. Co.
Audio Productions, Inc.
Bausch & Lomb Optical Co.
Bell & Howell Company
Bijou Amusement Company
Buensod-Stacey, Inc.
Burnett-Timken Research Laboratory
Byron, Inc.
The Calvin Company
Cinecolor Corporation
Cineffects, Inc.
Geo. W. Colburn Laboratory, Inc.
Consolidated Film Industries
DeLuxe Laboratories, Inc.
De Vry Corporation
Du-Art Film Laboratories, Inc.
E. I. du Pont de Nemours & Co., Inc.
Eastman Kodak Company
Max Factor, Inc.
Federal Manufacturing and Engineering Corp.
Fordel Film Laboratories
General Electric Company
General Precision Equipment Corp.
- Ampro Corporation
- Askania Regulator Company
- General Precision Laboratory, Incorporated
- The Hertner Electric Company
- International Projector Corporation
- J. E. McAuley Mfg. Co.
- National Theatre Supply
- The Strong Electric Company

W. J. German, Inc.
Guffanti Film Laboratories, Inc.
Hunt's Theatres
Hurley Screen Company, Inc.
The Jam Handy Organization, Inc.
Kollmorgen Optical Corporation
Lorraine Carbons
March of Time
J. A. Maurer, Inc.
Mecca Film Laboratories, Inc.
Mitchell Camera Corporation
Mole-Richardson Co.
Motiograph, Inc.
Motion Picture Association of America, Inc.
- Allied Artists Productions, Inc.
- Columbia Pictures Corporation
- Loew's Inc.
- Paramount Pictures Corporation
- Republic Pictures Corp.
- RKO Radio Pictures, Inc.
- Twentieth Century-Fox Film Corp.
- Universal Pictures Company, Inc.
- Warner Bros. Pictures, Inc.

Movielab Film Laboratories, Inc.
National Carbon
National Cine Equipment, Inc.
National Screen Service Corporation
National Theaters Amusement Co., Inc.
Neighborhood Theatre, Inc.
Neumade Products Corp.
Northwest Sound Service, Inc.
Producers Service Co.
Radiant Manufacturing Corporation
Radio Corporation of America, RCA Victor Division
Reid H. Ray Film Industries, Inc.
Reeves Sound Studios, Inc.
S.O.S. Cinema Supply Corp.
SRT Television Studios
Technicolor Motion Picture Corporation
Terrytoons, Inc.
Theatre Holding Corporation
Titra Film Laboratories, Inc.
United Amusement Corp., Ltd.
Westinghouse Electric Corporation
Westrex Corporation
Wilding Picture Productions, Inc.
Wollensak Optical Company